

Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region

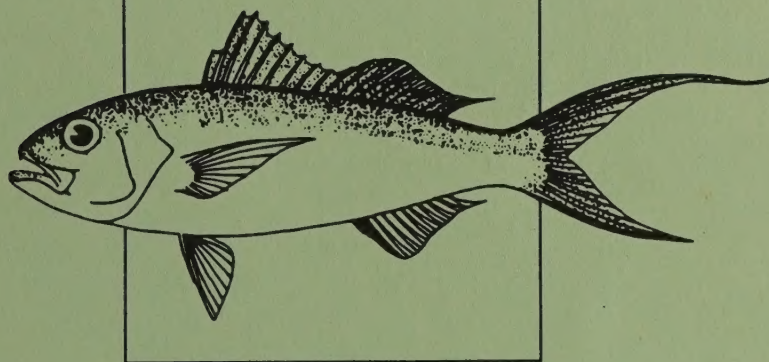
1991 Annual Report

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August 1992

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National Marine Fisheries Service
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for the

Western Pacific Regional Fishery Management Council

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**Bottomfish and Seamount Groundfish Fisheries
of the Western Pacific Region**

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**Western Pacific Regional Fishery Management Council
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Table of Contents

	<u>Page</u>
Introduction	1
Discussion of Descriptors	
Landings Information	1
Effort Information	2
Participation Information	2
Economic Information	2
Discussion of Indicators	
Aggregate CPUE	2
Mean Size	2
Percent Immature	2
Spawning Potential Ratio	2
Economic Indicators	3
Summary of Descriptor Information	
American Samoa	3
Guam	3
Hawaii	
Main Hawaiian Islands	4
Northwestern Hawaiian Islands	4
Northern Marianas	5
Analysis of Indicators	
American Samoa	5
Guam	6
Hawaii	
Main Hawaiian Islands	6
Northwestern Hawaiian Islands	6
Seamount Groundfish	7
Northern Marianas	8
Recommendations	
American Samoa	8
Guam	8
Hawaii	9
Northern Marianas	9
1991 Descriptors and Indicators	
American Samoa	11
Guam	33
Hawaii	57
Northern Marianas	99
Appendix 1. Armorhead Stock Assessment	113
Appendix 2. NMFS Administrative Activities	125
Appendix 3. 1991 Enforcement Activities	127
Appendix 4. Habitat Conditions	128
Appendix 5. Plan Team Membership	129

Introduction

The 1991 annual report is the third report to be prepared in a streamlined format, with greater emphasis on analysis of indicators than had been presented with the module approach of previous years.

The report has been formulated around a series of descriptors and indicators. The descriptors are designed to give a reader a basic understanding of recent trends in landings, effort, participation, revenue and prices for the bottomfish fisheries of American Samoa, Guam, Hawaii and the Northern Mariana Islands. In addition, should management action be recommended, the descriptor information provided will aid in assessing the potential impacts of the action on fishery participants. The indicators, on the other hand, are quantifiable and measurable tools used to identify signs of stress in the stocks or the fishery. It is on the basis of these indicators that the Plan Team (PT) may identify "yellow light" situations and recommend that either management action or additional study be undertaken.

This year's report is organized in the following manner: First a brief explanation of each descriptor and indicator is provided. Second, a summary of the descriptor information and changes observed in the fishery in 1991 is presented. This is followed by an analysis of the indicators, highlighting any "yellow light" situations based on these indicators. Plan Team recommendations and data needs are then discussed. The summary section of the annual report is followed by detailed time series descriptor and indicator information for each area. Each figure is accompanied with a description of the data source, method of calculation, and interpretation, if any. Finally, a series of appendices are included. These contain information on (1) armorhead stock assessment for 1991, (2) NMFS 1991 administrative activities, including NWHI permit issuances, protected species interactions, and observer programs, (3) enforcement activities, (4) habitat conditions and (5) 1991 PT membership.

Descriptors

The fishery descriptors include the following types of information:

Landings Information: Time series information on aggregate catch for each of the areas show recent trends in total bottomfish harvest. For American Samoa and Guam, estimates of both the commercial landings and the total landings (commercial, recreational and subsistence combined) are available. For Hawaii and the Northern Marianas, landings information represent only the commercial harvest.

Changes in species catch composition is also provided for the Main Hawaiian Islands (MHI) and the Northwestern Hawaiian Islands (NWHI). Where possible, information

for all descriptors have been presented by zone in the NWHI. For 1991 only, pounds landed, by species, are presented in tabular form for each area except Hawaii. For Hawaii, NWHI bottomfish management unit species (BMUS) landings by species are provided for 1986 through 1991. No species-specific information is provided for the MHI fishery.

Effort Information: Effort is measured in number of trips for Hawaii, and the CNMI, and in both hours fished and trips taken for American Samoa and Guam.

Participation Information: Estimates of the number of vessels making bottomfish landings are provided for all areas.

Economic Information: Time trends in economic performance are characterized by plots of total ex-vessel revenue, aggregate average price levels, and price trends over time for major species (Hawaii only). In time-series of prices and revenues, it is appropriate to adjust value for the rate of inflation so that values throughout the time period are comparable (based on a consistent purchasing power for the dollar). For each of the areas, both the unadjusted and adjusted aggregate average price and aggregate revenues are plotted to give the reader a better picture of the relative change over time.

Indicators

Indicators were developed as tools for identifying signs of stress in the stocks or the fishery which deserve further investigation and/or a management response. The PT has developed the following indicators:

Time Trend in Aggregate Catch Per Unit Effort (CPUE): If the current year's aggregate CPUE is less than 50 percent of the average aggregate CPUE for the first 3 years of available data, then there may be some cause for concern. CPUE information is available for all areas, and, in addition, research CPUE is available for SE Hancock Seamount.

Time Trend in Mean Size: If there has been a significant reduction in mean size of individual fish for a species over time, the stock may be stressed by the fishery. Mean size information is provided for 7 species in Hawaii and 12 in Guam. No mean size information was available at this time for American Samoa or the Northern Marianas.

Percent of Catch less than the Size at Maturity: If over 50 percent of the catch is less than the size at maturity, a stock may be stressed by the fishery. Due to the lack of size at maturity information for species in American Samoa, Guam and the CNMI, this indicator is provided only for the Hawaii fisheries.

Time Trend in Spawning Potential Ratio (SPR): The SPR is the ratio of the spawning stock biomass per recruit at the current level of fishing to the spawning stock

biomass per recruit that would occur in the absence of fishing. According to the overfishing definition contained in the Bottomfish FMP, if SPR is less than or equal to 0.2 recruitment overfishing has occurred. This year this indicator has been calculated for the 5 major species in the Main Hawaiian Islands and the armorhead stocks of the seamounts.

An estimate of the "worst case" SPR was calculated for American Samoa stocks for the second year using Dory Project data to estimate the virgin population CPUE and Hawaii percent immature information.

Time Trend for Economic Indicators: The two economic indicators selected by the PT were revenue per trip and cost per trip. Revenue per trip plots are presented for all areas except the MHI. A more valuable indicator for the commercial fisheries which may be available in the future would be net revenue (ex-vessel revenue minus costs).

Summary of Descriptor Information

American Samoa: The American Samoa fishery has been plagued by a series of hurricanes since 1987. The declining bottomfish harvests since 1987 reflect the impact of two of the three recent hurricanes as well as the departure of several highline fishermen from the fishery. The total 1991 landings increased 25 percent from 1990 levels but still remained much lower than those observed in earlier years (a 83 percent decrease compared to average 1983-1986 landings). Unfortunately, a third hurricane struck American Samoa in December 1991, causing further damage to the bottomfish fleet.

The general trend in effort mirrors that in landings. This does not necessarily suggest a problem with the resources but may depict an actual shift of commercial boat owners and fishermen to more lucrative and stable lines of work. The slight increase in 1991 (8 percent more trips, 28 percent more hours) is believed to reflect an actual revived interest in the fishery.

Prices have remained relatively stable in American Samoa since 1986 and there was a slight increase in 1991 total revenue with the increased landings. The relative importance of bottomfish compared to the revenue generated from other species has been declining, however. Most of the full time bottomfish fishermen have left the fisheries and the supply of locally caught bottomfish has been supplemented by a significant quantity of imported bottomfish species from Western Samoa and Tonga.

Guam: The fairly large fluctuations over time in bottomfish landings in Guam appear to be due more to entry and exit patterns of fishermen, rather than changes in fish stocks. The total bottomfish landings increased in 1991 compared to 1990 (13 percent).

The number of trips taken also increased (2,444 trips compared to 2,060 in 1990). This increase in effort is attributed to exceptionally calm weather in 1991 as well as the opening of Agat Marina. This site was not formally sampled except to count total number of trailers and is expected to have a greater ratio of bottomfish to other fishery participants than the Agana Boat Basin. This situation is justification for increasing the survey to incorporate the Agat Marina.

The estimated number of boats participating in the bottomfish fishery has risen steadily over the past several years and increased almost 50 percent between 1990 and 1991. This increase cannot be fully explained but is thought to be a reflection of the healthy economy which has made it possible for more residents to afford boats, as well as the calm weather in 1991.

While total bottomfish harvests are up, the commercial landings and revenues declined by 41 and 46 percent, respectively. Average price received for bottomfish declined by 7 percent in 1991. Again, the fluctuations are believed to be largely effort based. With a small number of total participants, the entry or exit of certain highliners will result in significant changes in the total harvests. The market for locally caught bottomfish is impacted both by imported fish from other near-by areas and the sale of reject longline-caught pelagic fish.

Main Hawaiian Islands: Only commercial data are available for both the MHI and NWHI fisheries. In 1988, there was a dramatic increase in MHI bottomfish landings due to a bonanza uku harvest. Since that time there has been an steady decline in total landings, mainly due to decreasing abundance in uku. The 1991 landings continued this trend, decreasing 12 percent compared to 1990. Landings are now down to pre-uku bonanza levels. Estimates of both number of vessels and number of trips also show a continued decline from 1988 peak values.

Total ex-vessel revenue from the MHI has also continued a general decline since 1988, mainly due to decreased landings. In 1991, however, average bottomfish price also declined.

Northwestern Hawaiian Islands (Mau Zone): Mau Zone landings were down dramatically, declining 59 percent from 1990. The total number of boats remained relatively stable from 1990 to 1991 but the number of trips increased by 52 percent. In addition, landings per trip decreased by 65 percent.

Prior to 1991, the trip and vessel information was derived from the NMFS and HDAR market monitoring program which did not capture the activities of several Mau zone vessels based on Kauai. These vessels tend to be smaller in size and make more trips of shorter duration than the vessels which had been sampled through the Oahu-based market monitoring program. The addition of data on Kauai-based Mau zone boats complicate the interpretation of the changes observed in the fishery. Because of the different characteristics of these vessels, the changes may be somewhat overemphasized.

Northwestern Hawaiian Islands (Ho'omalū Zone): The landings from the Ho'omalū zone increased by 64 percent in 1991. The catch composition changed slightly, with increases in uku and onaga and decreases in butaguchi, opakapaka and hapuupuu. The fleet size decreased by one vessel in 1991. The four remaining vessels were more active in 1991, however, with total trips increasing by 88 percent compared to 1990.

Available revenue data are not broken down by zone. Total NWHI revenue decreased slightly, reflecting the overall (both zone combined) decrease in total landings. NWHI aggregate average price has remained relatively stable.

Northern Mariana Islands (CNMI): Like Hawaii, only commercial data are available at this time for the Northern Marianas fishery. The commercial fishery continued to decline in 1991, with landings approximately half that in 1990 and only about one seventh what they were in 1987-88. The number of vessels participating in the fishery dropped from 29 to 19, but the total number of trips decreased only slightly in 1991.

The average price received for bottomfish increased to an all time high of \$2.83 in 1991. This increase in price is most probably related to a decreasing bottomfish harvest while market demand has remained constant or even increased. Total ex-vessel revenue to the fleet decreased by 44 percent, however, due to the large decline in landings.

The decline in the bottomfish fishery is attributable to several factors. The "preferred" fishery is the pelagic fishery and most fishermen turn to bottomfishing only when the market for pelagic fish is saturated. As Saipan's population has increased, so has the demand for pelagic fish. Therefore, there is less incentive for fishermen to switch to bottomfish fishing. In addition, the number of "highliners" is small and many of the most active fishermen have been leaving the fishery recently for a variety of reasons including loss of vessel, more lucrative job opportunities, and other demanding obligations which preclude fishing. Finally, the fishery has always been a small and somewhat erratic fishery. Knowledge of grounds and fishing techniques was traditionally passed down from experienced fishermen to novices but this network of information transfer appears to have broken down.

Analysis of Indicators

American Samoa: CPUE remained about the same as that observed in 1990. The highest CPUE in recent years occurred in 1988 and has declined since that time (Figure AS-6). This decrease may be partially attributed to a combination of some new, inexperienced boats entering the fishery and a lower ratio of commercial to subsistence/recreational fishermen. The first 3 years of available data were collected during the Dory Project (1974-1976). The historical base CPUE calculated from this information was 14.8 pounds per hour. The 1991 aggregate CPUE (10.0 lbs per hr) is 68% that of the historical base.

Estimates of the "worst case" scenario SPR was .33 for 1991 (see Figure AS-7), well above the 0.2 threshold which defines recruitment overfishing. **Based on the indicator criteria provided, no "yellow light" situations were identified and no management action is recommended at this time. However, DMWR biologists should contemplate a supplemental locally administered program to investigate the continuous decline in landings and CPUE.**

Guam: The CPUE has fluctuated between 5 and 8 pounds per hour, but has been fairly stable for the past 5 years. The mean size data available for the past 10 years do not indicate much decline for any of the 12 species examined. **Both the CPUE and the mean size indicators suggest that no management action needs to be taken at this time.**

Main Hawaiian Islands: The trend in MHI CPUE continued downward and in 1991 was less than half that of the average of the first 3 years of data (1947-1949), **signifying a yellow light condition.** The mean weight indicator proved difficult to interpret. Except for opakapaka, the mean weights observed for most MHI species increased in 1991. MHI onaga catch had the highest percentage of immature fish, and is the only species where the percent of the catch immature was consistently over 50 percent, **suggesting a "yellow light" condition.**

The SPR indicator was calculated for five major species. SPR estimates for all of these species are above the 0.20 "critical" level used as an indication of recruitment overfishing. However, onaga continued its decline, with a most recent SPR of 0.21. The apparent increases in ehu, opakapaka, uku and ulua SPR are a good sign, but may be in response to the recent increases in aggregate CPUE driven by uku CPUE rather than a reflection of actual improvement in the condition of each of these stocks.

The continuing decline of CPUE to a level triggering a yellow light condition, together with the other indicators reaffirms the PT's concern that the stocks are in a stressed condition and management action is needed. The PT in 1990 provided the Council with a discussion of management alternatives, The PT's preferred alternative at that time was the institution of a closed season, while recognizing that a minimum size limit might be more palatable to industry. The PT reminds the Council and the State of Hawaii that the 0.20 SPR threshold value is when recruitment failure may occur and cautions against waiting until that point to impose management measures. The PT urges the State of Hawaii and the Council resolve any jurisdictional issues and move forward to implement a management regime for the MHI bottomfish fishery as soon as possible.

Northwestern Hawaiian Islands (Mau Zone): CPUE data are only available for the NWHI fishery as a whole since 1986 and by zone since 1988. The combined Mau Zone and Ho'omalulu zone CPUE has been steadily decreasing since 1987, and the 1991 value is 59 percent that of the average of the first 3 years (1986-1988). The Mau Zone CPUE have been decreasing since 1989, with 1991 values decreasing by

25 percent from 1990. In general, mean weights of fish in NWHI are larger than those in MHI catch. Mean weights of ehu continued to decline while opakapaka, onaga, uku and butaguchi increased. All of the five major species assessed (opakapaka, onaga, ehu, uku and ulua) had less than 50 percent immature fish in the catch.

SPR values have been steadily increasing for the onaga, hapuupuu, ehu, opakapaka and uku. The SPR calculations used CPUE values from the HDAR data rather than from the NMFS and HDAR shoreside monitoring program. The CPUE time series calculated from the HDAR catch reports is increasing, while the values derived from the shoreside monitoring program have been decreasing. The reason for this is unknown but may reflect the fact that the submission of state catch reports was made a federal requirement fairly recently. This may have increased compliance with state reporting requirement by larger Mau zone vessels with higher CPUE levels. **No restrictive management action is recommended at this time. However, the changes which have been observed in the fishery and the discrepancies which have been discovered in the data need to be investigated in greater detail. The PT recommends that such an analysis take place. In addition, due to on-going data inadequacies, the PT recommends that a mandatory logbook program be instituted for the NWHI fishery (both Mau and Ho'omalua zones) as soon as possible.**

Northwestern Hawaiian Islands (Ho'omalua zone): The CPUE values had been steadily decreasing since 1988, but increased slightly (3%) in 1991. Mean weights of ehu continued to decline while onaga and butaguchi increased. All of the five major species assessed (opakapaka, onaga, ehu, uku and ulua) had less than 50 percent immature fish in the catch.

The most recent SPR values calculated for the onaga, hapuupuu, ehu and opakapaka declined somewhat but remain above 0.50 all cases. **No restrictive management action is recommended at this time. However, the PT recommends that a mandatory logbook program be implemented as soon as possible.**

Seamount Groundfish (Armorhead): No fishing has been allowed on the armorhead stocks of the S.E. Hancock Seamount since the moratorium began in August, 1986. CPUE, based on research longline catches, declined in 1991. The decline in CPUE, coupled with the absence of high "fatness index" armorhead in the catch, indicates that no recruitment occurred in 1991.

SPR within the EEZ (S.E. Hancock Seamount) is approximately one percent, far below the threshold level for recruitment overfishing of 20 percent. Outside the EEZ, where 99 percent of the known armorhead habitat occurs, the SPR value was estimated at 8.2 percent.

The information presented above was provided to the Council earlier with the recommendation that the moratorium be extended for an additional 6 years. The

Council concurred with the PT and took action at its March meeting to request a 3 year extension.

Northern Mariana Islands: The bottomfish catch per trip decreased by 46 percent in 1991. The average catch per trip is subject to significant biases (e.g., changes in trip length and relative amounts of bottomfishing compared to trolling). Because of this the catch per trip information is not a very good measure of CPUE. Unfortunately, it is the only measure readily available from the commercial landings data system. It may be possible to improve this measure of CPUE by using only those trips which landed bottomfish species exclusively. While such a calculation may be sensitive to other biases due to small sample size, it should be investigated in the future. **The indicators do not suggest the need for any management action.**

Recommendations

American Samoa

Because of general budgetary constraints, DMWR was unable to fulfill several fishery monitoring programs recommended by the PT in the 1990 annual review. The recommended programs were:

1. Reconstruct virgin stock CPUE and size distribution information for key species by fishing in unexploited areas such as Rose Atoll.
2. Establish MSY estimates for the shallow water complex.
3. Determine size at maturity for key species.
4. Collect length data from key species.

This information is essential to gauge and define overfishing as defined by the recent amendment to the Bottomfish and Seamount Groundfish FMP.

Recommendations 3 and 4 are believed to be attainable utilizing existing resources and therefore should be implemented in 1992.

Even though the indicators used by the PT provide no "yellow light" situation with the fishery, DMWR biologists should contemplate a supplemental locally administered program to investigate the continuous decline in landings and CPUE.

Guam

The red-gilled emperor accounts for a large percentage of Guam's bottomfish harvest (27 percent in 1991). SPR values cannot be calculated without an estimate of virgin condition CPUE. Therefore, the PT wishes to once again recommend that **funding be provided to initiate a joint venture project with the CNMI to establish such a baseline estimate.**

Since there are two distinct fisheries of importance in Guam, the PT also **recommends that the CPUE information be analyzed separately for the shallow water and deepwater fisheries.**

Hawaii

The PT has for several years expressed concern about the health of the MHI fishery. In addition, questions have arisen over the need for limited entry in the Mau Zone. Changes observed in the fishery in 1991 also indicate that the NWHI fishery, especially in the Mau zone, may warrant closer examination. At the same time, no recent estimate of the MSY for either fishery appears to exist. **The PT recommends that a simple surplus production model utilizing aggregate catch and effort data be constructed both for the MHI and the NWHI fishery in order to re-estimate the MSY level of catch and effort which could serve as annual indicators.**

Increasingly, less of the MHI bottomfish harvest is being "captured" by the NMFS and HDAR market monitoring program. Therefore, the estimates of species composition and even total landings from this data source has become very suspect. The HDAR catch reporting system is considered a more reliable source of information on the fishing activity in this fishery. Therefore, **the PT recommends that the HDAR catch reports be used when preparing the 1992 annual report and that the HDAR team member be assigned the responsibility for those analyses.**

The problems in interpreting the Mau zone 1991 information has been discussed above. **The PT recommends that the existing NMFS and HDAR data sets be examined in greater detail in order to differentiate between real trends in the fishery and changes which are artifacts of changes in the data base.**

Finally, and perhaps most importantly, it has become increasingly apparent that the existing data collection systems, both in terms of the market monitoring program and the HDAR catch reports are inadequate. It has been increasingly difficult to monitor the NWHI fishery shoreside from Honolulu with the growing number of vessels fishing out of Kauai. The HDAR catch reports do not provide sufficiently detailed information on the amount or location of effort. A better data collection system is needed if the PMT and other scientific staff are going to be able to provide information necessary to monitor the NWHI fisheries, assess the status of the stocks and develop effective management regimes in the future. Therefore, **the PT recommends that a mandatory logbook program for all NWHI federal bottomfish permit holders be developed and implemented as soon as possible. The development of the logbook forms should be closely coordinated with the industry.**

Northern Marianas

Bottomfishing in the CNMI is declining as local fishermen focus their efforts on pelagic trolling or other tourist related interests. This decline is expected to be short

lived evidenced by the overwhelming interest in a recent bottom longline training project and apparent increasing market demand. During 1992, DFW staff plan to investigate charter boat activities and their impact on the local fisheries market. **The PT supports this investigation and recommends that DFW biologists develop a system for collecting biological information from this fleet.**

While the recent training project was a good start, the local fishermen are in serious need of continuing education related to the techniques and equipment introduced during this project. **The PT recommends that the DFW hold a workshop or series of workshops for fishermen which would cover the following topics: (1) proper operation and interpretation in the use of fathometers and nautical charts, (2) electric reel repair, (3) anchoring techniques, (4) marketing, and (5) fish handling.**

**American Samoa
1991 Descriptors and Indicators**

	<u>Page</u>
Introduction	13
Descriptors	
<u>Landings Information</u>	
Aggregate Catch	15
1991 Landings by Species	17
Commercial Landings	18
<u>Effort Information</u>	
Number of Trips, Hours Fished	20
<u>Participation Information</u>	
Number of Boats Landing Bottomfish	22
<u>Economic Information</u>	
Aggregate Revenue	18
1991 Average Price by Species	24
Aggregate Average Price	25
Indicators	
Aggregate CPUE	26
Estimated Aggregate Spawning Potential Ratio (SPR)	27
Revenue Per Trip	29
Recommendations	31

INTRODUCTION

The people of American Samoa have been harvesting bottomfish species, using canoes, for subsistence use over the millennia. But it was not until the early 1970's that the bottomfish fishery developed into a commercial venture utilizing motorized boats. A government subsidized program, called the Dory Project, was initiated in 1972 to develop the offshore commercial fisheries resulting in an abrupt increase in the fishing fleet and total landings. In 1982 a fisheries development project aimed at exporting high-priced deep water snappers to the Hawaii auction caused another notable increase in both bottomfish landings and revenue. Between 1982 and 1988, the bottomfish fishery comprised as much as 50% of the total commercial catch. Since 1988 the nature of the fishery has changed dramatically with a shift of importance towards trolling as revealed by a 72% decrease in bottomfish landings between 1988 and 1991. This was a result of the decrease in the number of full-time commercial fishermen who normally prefer the more profitable bottomfish method to trolling. The effects of three hurricanes that struck American Samoa in 1987, 1990 and in 1991 can be seen in some of the trends in the fishery.

Since the onset of DMWR's offshore data collection efforts in the early 1970's, monitoring was done on Tutuila through an interviewing program of only commercial fishers. With the assistance of the Western Pacific Fisheries Information Network (WPACFIN), a new sampling program which sampled commercial and recreational boats, was implemented in October 1985. In this creel survey, boats landing catches in designated areas were interviewed and their catches examined. For two weekdays and one weekend day per week, DMWR data collectors sampled offshore fishers between 0500 and 2100 hours. Two DMWR samplers based on the Manu'a islands collect fisheries data from the Tau, Ofu and Olosega fleet.

The notable drops in landings, number of trips, and the number of boats landing bottomfish (Figures AS-1,3,4) are primarily repercussions of two hurricanes that struck American Samoa in January 1987 and in February 1990. The 72% decrease in the estimated bottomfish landings between 1988 and 1991, and the observation that the fishery was generally smaller in the past four years than it was any time between 1982 and 1986 (Figure AS-1), can be partially attributed to the departure of several highliners from the fishery. A decrease in the number of full-time fishermen was also apparent during DMWR's quarterly vessel inventory and frequent contacts with the relatively small number of bottomfish fishermen. Effects of the hurricane that struck the territory during the first week of December 1991, will be more evident in next year's catch statistics.

The CPUE (catch per hour) dropped during the past three years but was somewhat higher than that of the 1985-1986 period (Figure

AS-6) when fishing activity and landings were high. The average bottomfish CPUE for the first 3 years of available data (1974 - 1976) from the Dory Project summaries (refer to PMT's 1990 annual review) prepared by WPACFIN, was greater than the current year's CPUE. However the current year's CPUE, was not less than 50% of these first 3 years' CPUE, and therefore prompts no yellow light situation. Additional comparable analysis of the bottomfish data using a "worst case scenario from Hawaii's worst 5 species" (refer to the analysis in Figure AS-7) revealed no urgent problems with the stock. However, further analysis utilizing the MSY of the bottomfish complex should be performed to substantiate this claim.

The bottomfish fisheries of American Samoa are typically small boat, one-day fisheries. During 1991, a total of 20 domestic boats landed bottomfish in the territory. Inflation-adjusted revenue for the fishery was estimated to be \$27,000. Virtually all the catch was sold locally. Fishing is mostly trolling and bottomfishing.

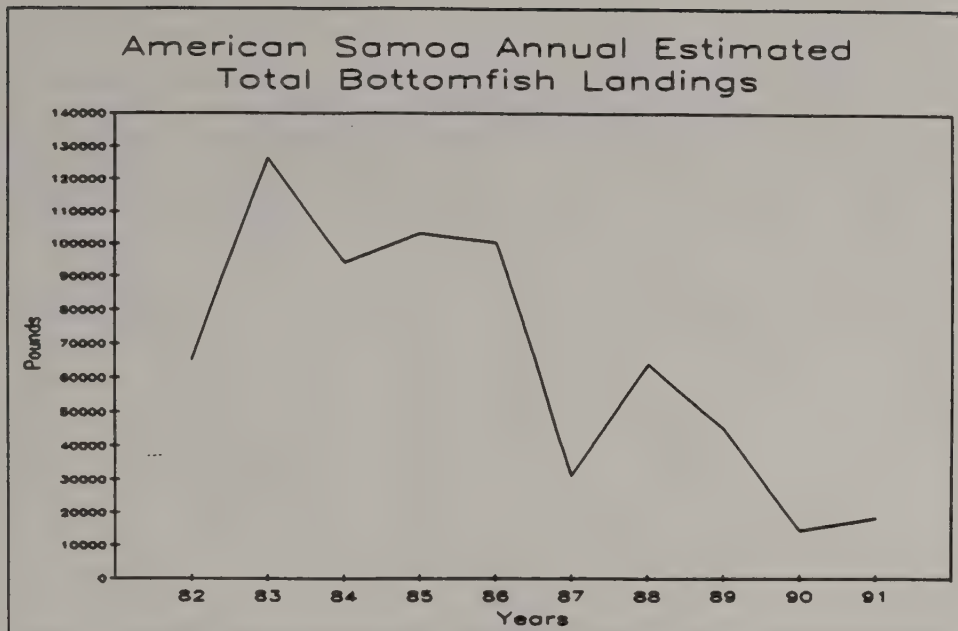


Fig. AS-1. American Samoa Annual Estimated Total Bottomfish Landings

<u>Years</u>	<u>Bottomfish Landings (lbs)</u>
1982	64942
1983	126327
1984	94104
1985	103115
1986	100356
1987	31007
1988	63845
1989	45278
1990	14506
1991	18133

Calculations: Bottomfish landings for 1982-84 are calculated by adjusting the sampled Tutuila data by the calculated annual percent coverage of the fleet, and then adding the similarly adjusted Manu'a landings to it. The 1986-present landings are from the creel survey expanded species composition files (.SPC) which contain the annual estimated total landings by species for Tutuila, and then adding the adjusted Manu'a landings. Calculating statistics for 1985 is more complicated because the sampling program changed from commercial fleet sampling only to creel sampling on October 1, 1985. Basically, monthly adjustments are made based on percent coverage for January to September, and the October to December .SPC files are added, and then the adjusted Manu'a data are added.

Interpretation: The substantial declines in landings in 1987 and 1990 were partially due to vessel losses caused by two hurricanes.

A slight increase in the 1991 landings is depicted despite the effects of another hurricane which struck the territory during the first week of December, 1991. Generally speaking, the bottomfish fishery is much smaller in recent years than it was any time between 1982 and 1986, a period where there was a relatively large fleet and fishermen were attracted to the more profitable bottomfish export program.

TABLE 1

American Samoa 1991 Estimated Total Bottomfish Landings

Species	Pounds	Species	Pounds
Blue lined snapper	2575	Emperor (misc)	326
Gray Jobfish	2426	Lehi (silverjaw)	256
Redgill Emperor	2026	Yellowspot grouper	200
Longnose Emperor	1451	Goldenline bream	126
Ehu (red snapper)	1115	Tomato grouper	120
Humpback Snapper	1075	Gindai (flower snap.	118
Lunartail grouper	967	Flagtail grouper	85
Kusakar's snapper	886	Giant grouper	75
Onaga (red snapper)	660	Orangespot emperor	67
Jacks (misc)	617	Onespot snapper	48
Opakapaka	581	Blue lined gindai	48
Black jack	562	Black snapper	26
Ambon Emperor	469	Bigeye emperor	16
Peacock grouper	468	Hawaiian Opakapaka	7
Twinspot/red snapper	348	Yellowtail snapper	3
Groupers (misc)	342	Snake mackerel	2
Total Bottomfish	18133		
Total BMUS	13094		

Because of the variability among years of the percent of the total sampled bottomfish catch that was identified to the species level, and because the bottomfish complex in American Samoa contains many more species (some important) than specified in the FMP, analyses of American Samoa bottomfish data are for the whole complex, not just for BMUS.

For 1982-85 sampling was done on the commercial fleet only (which was nearly all the fishing boats in those days), whereas since 1985 creel sampling has covered all boats. In the early years of the bottomfish fishery, virtually all bottomfishing was done by commercial boats. Analysis of creel data for 1986-87 indicates that over 98% of the landed bottomfish were still being sold. This percent decreased in subsequent years as the number of commercial boats has decreased. Therefore, it is believed to be valid to compare commercial data for years prior to 1986 to creel survey totals for years since 1986.

There has been no significant changes in the species composition of the bottomfish complex landed.

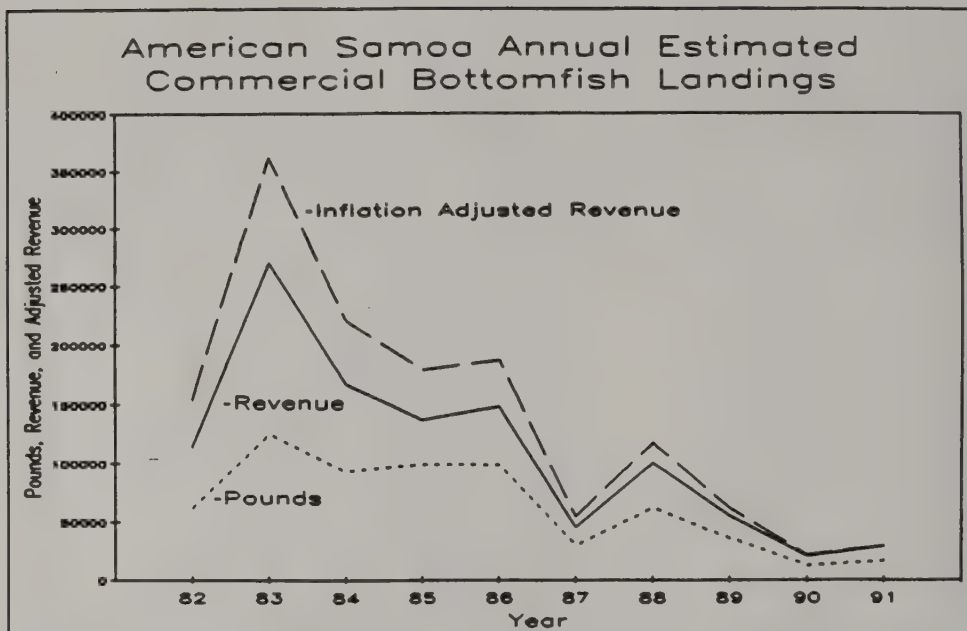


Figure AS-2. American Samoa Annual Estimated Commercial Bottomfish Landings

<u>Years</u>	<u>Commercial Landings</u>	<u>Revenues</u>	<u>Inflation Adjusted Revenues</u>
1982	62016	113678	153806
1983	125167	269083	361109
1984	92841	166917	219830
1985	99217	136781	178499
1986	98436	147507	186301
1987	29625	44956	54397
1988	61598	99775	117036
1989	35484	54630	61459
1990	12136	20109	20994
1991	15859	28651	28651

Calculations: A relatively straightforward, but complex, set of algorithms are used to estimate the commercial landings from the estimates of total landings created by the creel survey data expansion system. In short, the percent sold by fishing method is calculated monthly and multiplied by the percent species composition by month and then multiplied by the estimated total landings for that method and month, and the results are written to a data base. The estimated commercial landings of all bottomfish species are summed from that data base, as is the estimated revenue. Bottomfish revenues and inflation-adjusted revenues are plotted against the estimated commercial landings in figure 2.

Interpretation: Commercial landings mirror the total fishery in showing declined catches in recent years. Relative to total

landings, commercial landings decreased even more substantially in 1989 because the percent of the catch sold by bottom fishermen dropped from an average of about 95-98% in 1982-88 to only 78% in 1989, then rose to 84% in 1990. This year, this percentage rose slightly to 87%. The peak in 1983 portrays the high prices of deep water snappers exported to Hawaii while the trough in 1987 can be attributed to the effects of the 1987 hurricane. The slight increase in 1991 was encouraging despite the continuous influx of imported bottomfish from Western Samoa and Tonga and the effects of hurricane "Val" which struck during December 1991.

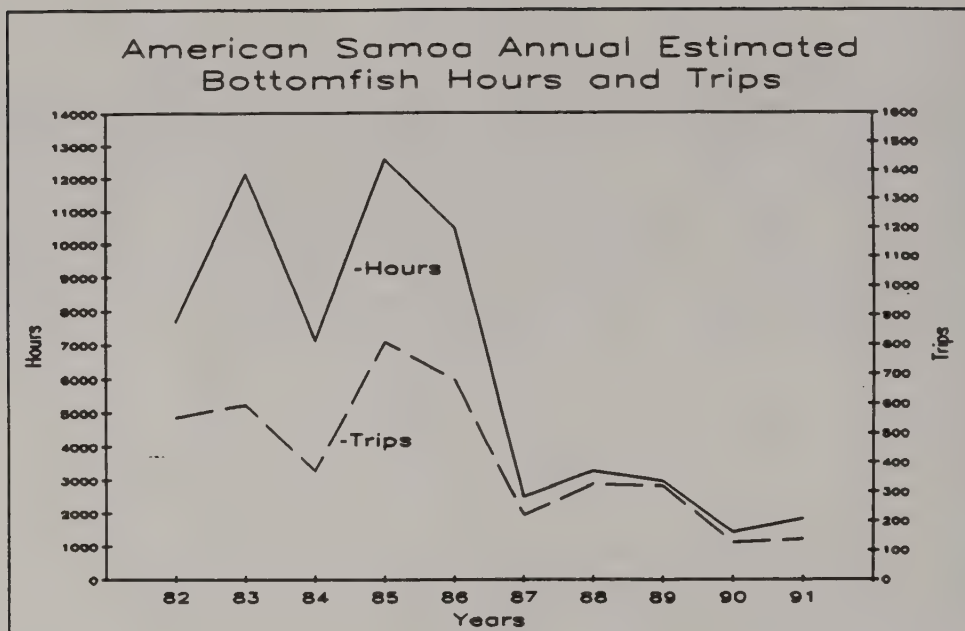


Figure AS-3. American Samoa Annual Estimated Bottomfish Hours and Trips

<u>Year</u>	<u>Hours</u>	<u>Trips</u>
1982	7654	554
1983	12118	597
1984	7105	374
1985	12575	806
1986	10463	679
1987	2488	220
1988	3247	327
1989	2954	320
1990	1422	128
1991	1818	138

Calculations: The annual estimated effort (hours) spent bottomfishing is calculated by dividing the annual estimated total bottomfish catch by the average CPUE (pounds per hour) from trips doing only bottomfishing. The annual estimated number of trips is calculated by dividing the estimated annual hours by the average length of a bottomfishing trip. The average length of a bottomfishing trip (not shown) is calculated by using only trips which exclusively bottom fished and for which the trip length was recorded. The total hours fished from those trips is then divided by the number of trips.

Interpretation: The sharp decline in the bottomfish landings since 1986 noted in Figure 1 is mirrored in this figure by the sharp decline in the level of effort expended in that fishery. This does not necessarily suggest a problem with the resource, but does depict an actual trend of commercial boat owners and fishermen

seeking other more lucrative and stable lines of work. It is believed that the slight increase in the number of trips and hours that occurred in 1991 reflects an actual revived interest in the fishery.

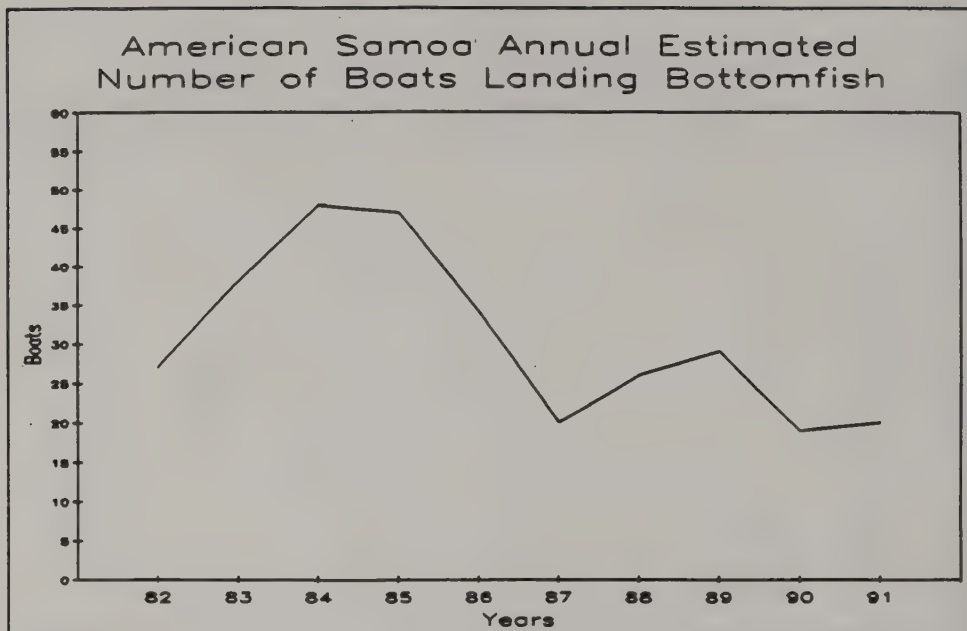


Figure AS-4. American Samoa Annual Estimated Number of Boats Landing Bottomfish

<u>Years</u>	<u>Boats</u>
1982	27
1983	38
1984	48
1985	47
1986	34
1987	20
1988	26
1989	29
1990	19
1991	20

Calculations: The level of sampling is so high and the total number of boats in Samoa so low, that the number of boats actually sampled in any year is virtually a census. Therefore, the annual estimate of the number of boats in the bottomfish fishery is simply obtained from the data base by counting the unique boats sampled during the year which landed any bottomfish species.

Interpretation: Again the decline in the fishery since 1985-86 is noted by a decline in the number of boats participating in it. The 1987 hurricane caused loss of all the Manu'a fleet, plus some of the Tutuila fleet. Several boats which contributed to the 1989 bottomfish annual landings didn't land any bottomfish in 1990 due to much needed repairs and their participation in non-bottomfish chartered trips. The increase in 1991, although quite insignificant, could have signified a recovering interest and

participation in the fishery. Unfortunately, about 90% of the domestic fishing fleet were affected by the December 1991 hurricane.

Table 2

American Samoa 1991 Estimated Average
Price of Bottomfish Species

Species	\$/LB	Species	\$/LB
Ehu (red snapper)	2.51	Onespot snapper	1.62
Flagtail snapper	2.50	Jacks (misc)	1.55
Onaga (red snapper)	2.35	Opakapaka	1.52
Blue lined gindai	2.00	Ambon emperor	1.50
Gindai	2.00	Peacock grouper	1.50
Kusakar's snapper	1.95	Hawaiian opakapaka	1.50
Humpback snapper	1.92	Golden lined bream	1.50
Gray jobfish	1.90	Yellowspot grouper	1.50
Lehi (silverjaw)	1.89	Bigeye emperor	1.50
Black jack	1.79	Black snapper	1.50
Lunartail grouper	1.77	Giant grouper	1.50
Redgill emperor	1.72	Emperors (misc)	1.50
Blue lined snapper	1.70	Orangespot emperor	1.50
Grouper (misc)	1.69	Twinspot/red snapper	1.50
Tomato grouper	1.66	Snake mackerel	1.50
Longnose emperor	1.62		
Bottomfish \$/lb	1.81		
BMUS \$/LB	1.83		

Calculations: When data are collected, the disposition of the catch is recorded, and if it is sold, the price is obtained whenever possible. The average prices reported in this table are calculated by dividing the total revenue by the sold weight in pounds for each species.

Interpretation: Average prices of locally caught bottomfish complex and BMUS species rose slightly in the past two years in spite of imported bottomfish species (Fig. AS-7) with no significant change in species price distribution.

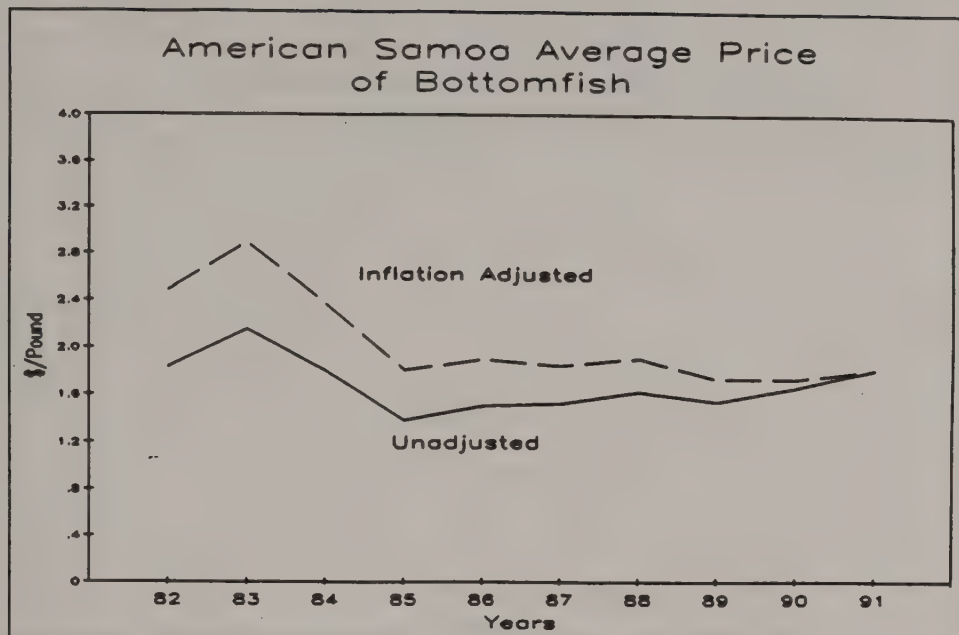


Figure As-5. American Samoa Average Price of Bottomfish

<u>Years</u>	<u>\$/lb</u>	<u>Inflation Adjusted \$/lb</u>
1982	1.83	2.48
1983	2.15	2.89
1984	1.80	2.37
1985	1.38	1.80
1986	1.50	1.89
1987	1.52	1.84
1988	1.62	1.90
1989	1.54	1.73
1990	1.66	1.73
1991	1.81	1.81

Calculations: The average price of all bottomfish species combined is calculated by dividing total bottomfish revenue by total sold weight. The inflation adjusted price is calculated by multiplying the unadjusted annual average price by the annually calculated consumer price index (CPI) for American Samoa using the current year as the base. For example, the CPI for 1991 was 135.3 and that for 1986 was 107.1. To calculate the inflation adjusted average price for 1986, multiply the unadjusted average price for 1986 by the 1991 CPI and divide by the 1986 CPI.

Interpretation: Prices were generally higher between 1982 and 1984 during the exportation of high-priced deepwater snappers to Hawaii, which peaked in 1983. After the collapse of this fishery starting in 1985, virtually all bottomfish landings were sold locally. Local prices for bottomfish have generally been stable since 1986.

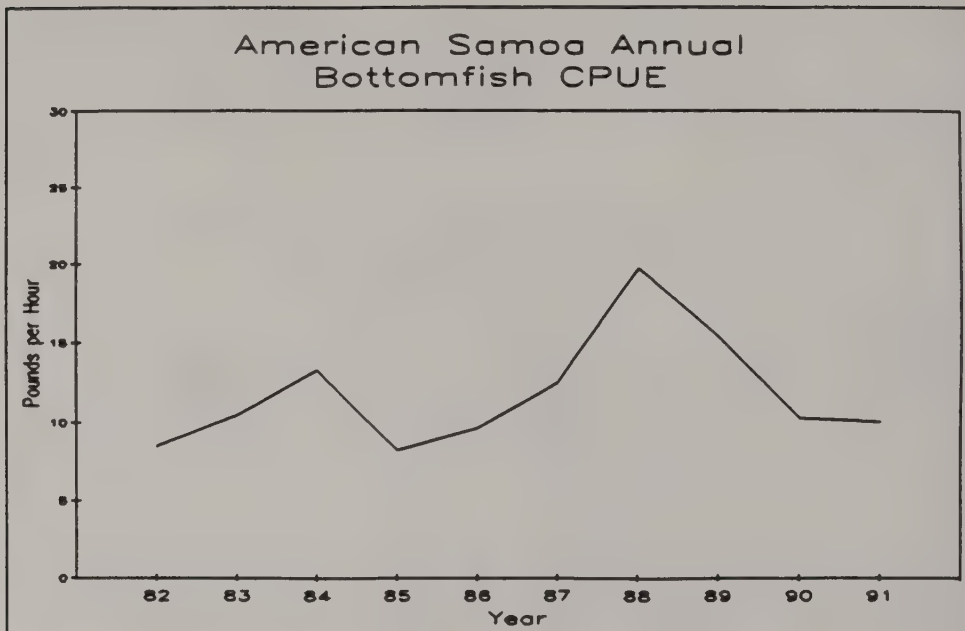


Figure AS-6. American Samoa Annual Bottomfish CPUE.

<u>Years</u>	<u>CPUE (Pounds per hour)</u>
1982	8.5
1983	10.4
1984	13.2
1985	8.2
1986	9.6
1987	12.5
1988	19.7
1989	15.3
1990	10.2
1991	10.0

Calculations: Catch per hour is calculated using only those trips which only bottom fished and recorded effort in hours. The average is calculated by using each CPUE from each trip as an observation and dividing by the number of trips.

Interpretation: The initial CPUE in 1983 and 1984 occurred during the intense fishing of some new fishing grounds for deep water snappers exported to the more lucrative Hawaii auction. A relatively high number of boats and local commercial fishermen participated in the fishery during this period. The drop in 1985 and 1986 might be expected following the ardent harvesting of the confined fishing grounds. Acute analysis of the bottomfish data and fisheries related factors should be performed to explain the peak in 1988. The continued decline in CPUE since 1988 can be partially attributed to a combination of some new, inexperienced fishers entering the fishery and the lower ratio of commercial to subsistence/recreational fishers.

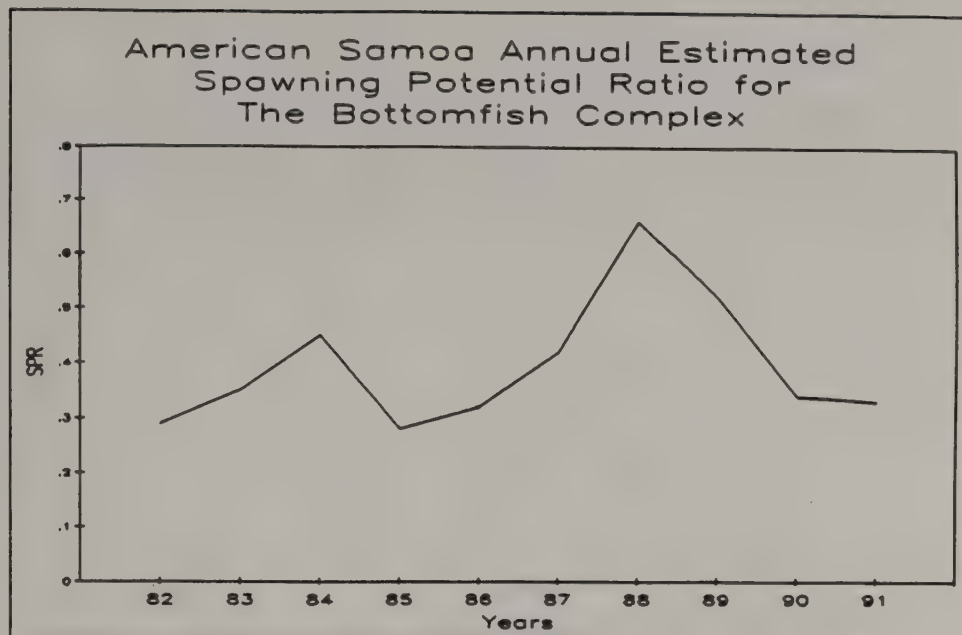


Figure AS-7. American Samoa Annual Estimated Spawning Potential Ratio for The Bottomfish Complex

<u>Years</u>	<u>SPR</u>
1982	.29
1983	.35
1984	.45
1985	.28
1986	.32
1987	.42
1988	.66
1989	.52
1990	.34
1991	.33

Calculations: The spawning potential ratio is calculated by dividing the current year's CPUE by the virgin population CPUE, and then multiplying by the ratio of the current percent mature to the virgin population percent mature fish in the catch. To estimate SPR's for American Samoa, the "Dory" project mean CPUE for 1975 and 1976 combined (refer to PMT's 1990 Annual Review page 20, Table AS-3) was used (due to the relatively complete and consistent raw data recorded during this period) to estimate virgin population CPUE (14.8 lb per hour). Since size and maturity data available for bottomfish in American Samoa are insufficient, the ratio of percent mature in the catch was estimated by substituting the average of the 5 species which have the lowest SPR in Hawaii. In this manner a "worst case" SPR was calculated to provide what should be a very conservative estimate of SPR for the American Samoa bottomfish complex.

Interpretation: The proxy "worst case" SPR for 1991 was 0.33, significantly above the threshold level of .20. According to this method of analysis, the bottomfish complex in American Samoa is not considered to be recruitment overfished. Supplementary analysis using the MSY for the bottomfish complex should be done to corroborate this affirmation.

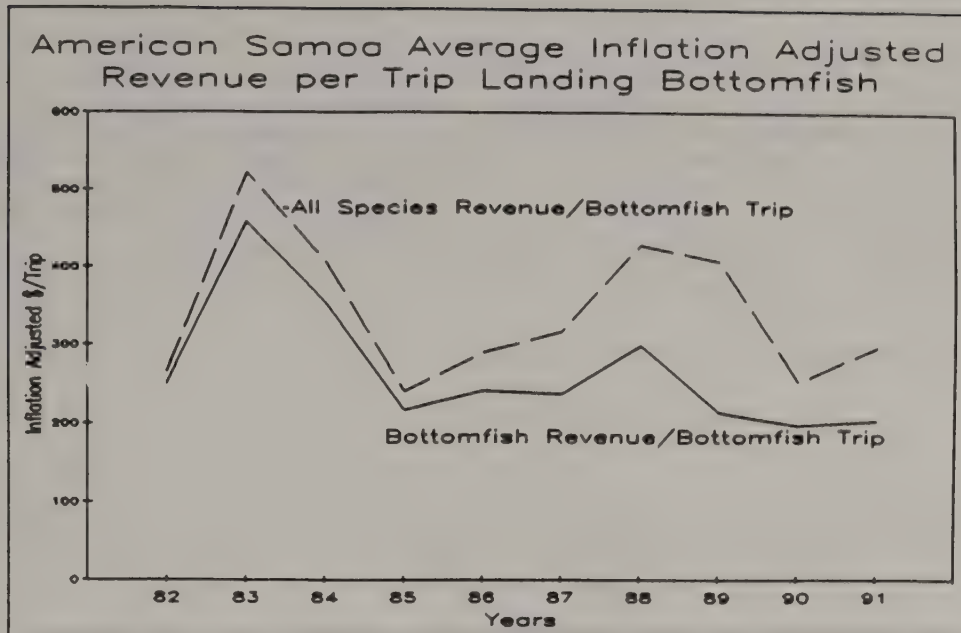


Figure AS-8. American Samoa Average Inflation-Adjusted Revenue per Trip Landing Bottomfish

Years	Bottomfish \$/Trip		All Species \$/Trip	
	Unadjusted	Adjusted	Unadjusted	Adjusted
1982	185	250	196	265
1983	341	458	388	521
1984	268	354	309	407
1985	166	217	184	240
1986	191	241	229	289
1987	196	237	262	317
1988	254	298	365	428
1989	190	214	362	407
1990	189	198	241	252
1991	203	203	296	296

Calculations: The average revenue per trip for all species is calculated by summing the revenue of all sales for any trip which landed any bottomfish species, and dividing by the number of trips. The average bottomfish revenue per trip is calculated from those same trips by summing the sales of only bottomfish species and dividing by the number of trips. Figure 8 plots the inflation adjusted bottomfish and all species revenues per trip for the period 1982-1991.

Interpretation: The distance between these two lines reflects the relative importance of bottomfish species in the total catch whenever any bottomfish is landed. The prominent importance of

bottomfish between 1982 and 1985 occurred during the targeting of deep water snappers for export. Bottomfishing was also the more profitable method of fishing during that period. The relative importance of bottomfish has generally been declining since 1985 as most of the full time commercial fishermen left the fisheries. The supply of locally caught bottomfish has been supplemented by the significant quantity of imported bottomfish species.

RECOMMENDATIONS

Because of general budget restraints, DMWR was unable to fulfill several fishery monitoring programs recommended by the Plan Monitoring Team (PMT) in last years's annual review. The recommended programs were:

1. Reconstruct virgin stock CPUE and size distributions information for key species by fishing in unexploited areas such as Rose atoll.
2. Establish MSY estimates for the shallow bottomfish complex.
3. Determine size at maturity for key species.
4. Collect length data from key species.

Recommendations 3 and 4 are believed to be attainable utilizing existing resources and therefore should be implemented in 1992.

Even though the indicators used by the PMT provide no "yellow light" situation with the fishery, DMWR biologists should contemplate a supplemental locally administered program to investigate the continuous decline in landings and CPUE.

Guam 1991 Descriptors and Indicators

	<u>Page</u>
Introduction	35
 Descriptors	
 <u>Landings Information</u>	
Aggregate Catch	36
1991 Landings by Species	38
Commercial Landings	39
 <u>Effort Information</u>	
Number of Trips, Boat Hours	41
 <u>Participation Information</u>	
Number of Boats	42
 <u>Economic Information</u>	
Aggregate Revenue	39
1991 Average Price by Species	43
Aggregate Average Price	44
 Indicators	
Aggregate CPUE	45
Mean Length for Major Species	46
Revenue Per Trip	55
 Recommendations	 56

Introduction

Guam's bottomfish fishery is a combination small scale local commercial and subsistence fishery. The majority of the participants are part-time fishermen who operate vessels less than 25 feet in length. Through the history of this fishery, fluctuations in annual harvest have been magnified by the consistent turnover in the few full-time highliner vessels. These vessels tend to be larger, represent a larger percentage of the effort expended in the fishery and impact the total annual harvest significantly. Guam has two relatively distinct bottomfish fisheries which can be separated by depth and species. The shallow water fishery (100-500 feet) contributes a larger portion of the overall bottomfish harvest. This fishery targets the red-gilled emperor (*Lethrinus rubrioperculatus*), also catching an assemblage of other snappers and groupers. The deep water fishery concentrates on the *Pristipomoides* snapper complex, focusing on the depths between 500 and 700 feet. Although Guam's bottomfish fishery has limited economic importance, the social importance carries strong cultural and subsistence values.

The Bottomfish Management Unit Species (BMUS) are the following species: *Cephalopholis urodeta*, *Epinephelus fasciatus*, *Variola louti*, *Caranx ignobilis*, *Caranx lugubris*, *Seriola dumerili*, *Aphareus rutilans*, *Aprion virescens*, *Etelis carbunculus*, *Etelis coruscans*, *Lutjanus kasmira*, *Pristipomoides auricilla*, *Pristipomoides filamentosus*, *Pristipomoides flavipinnis*, *Pristipomoides seiboldi*, *Pristipomoides zonatus*, *Lethrinus rubrioperculatus*, *Lethrinus amboinensis*. For Table 1 *Cephalopholis urodeta*, *Epinephelus fasciatus*, and *Variola louti* comprise the grouper category; *Caranx ignobilis*, *Caranx lugubris*, *Seriola dumerili* comprise the jack category; and *Lethrinus rubrioperculatus*, and *Lethrinus amboinensis* comprise the emperor category.

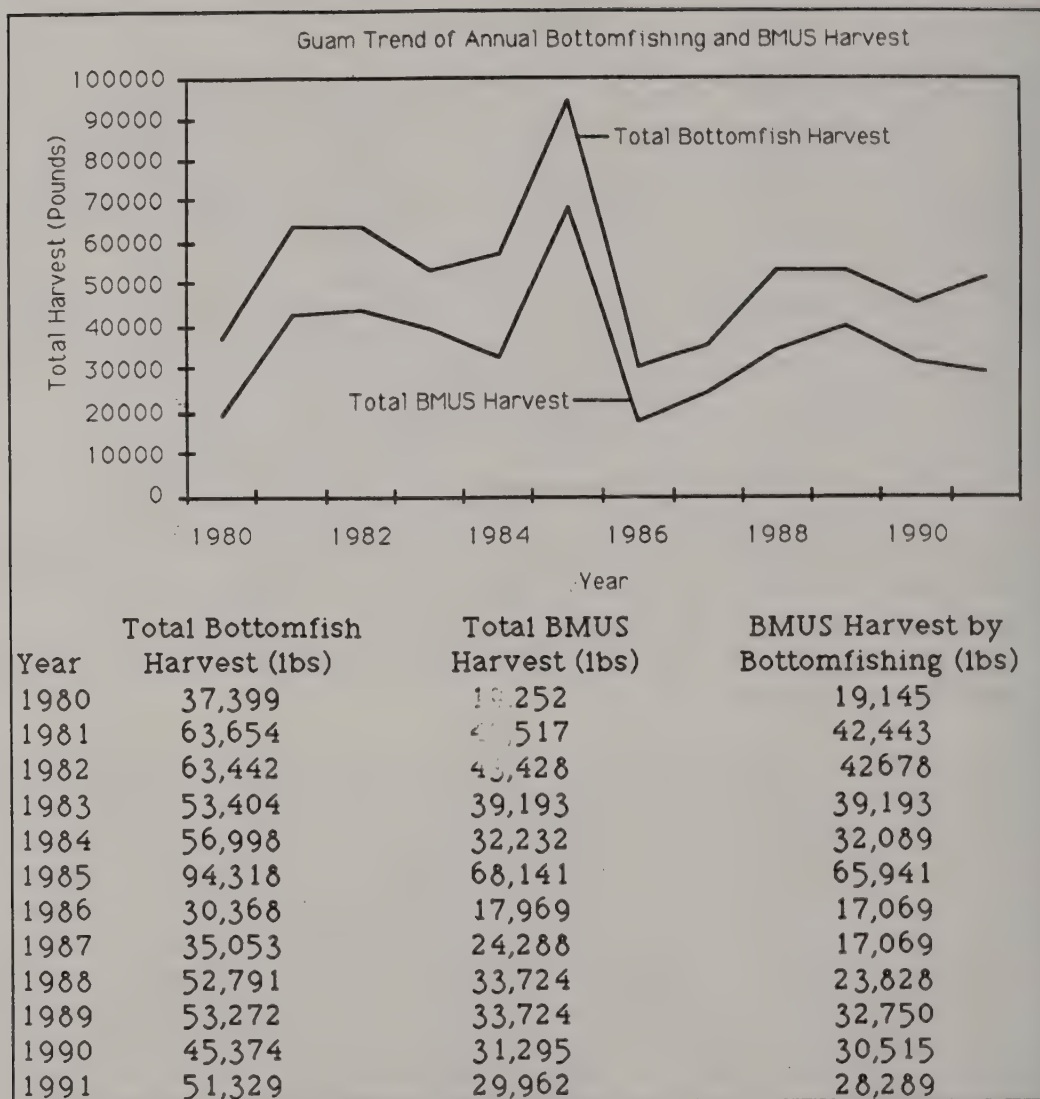


Figure G-1

Source: The DAWR offshore creel survey data as expanded by computer based algorithms by method of fishing. All unidentified catch was allocated to species categories based on the species percentage of the total catch.

Calculations: Generally speaking, the estimated total landings of the bottomfish species are selected from the creel survey expanded species composition files. However, the expanded estimates of catch by species must include at least a portion of the catch identified only by generic species codes categories. These generic categories (e.g. mixed shallow bottom fish) also include some non-bottomfish species according to the FMP definition (e.g. squirrelfish).

Interpretations: The fairly radical fluctuations in the bottomfish landings are due primarily to fluctuations in the fishery, not the fish stocks. The 1985 peak and 1986 crash are predominantly due to a few highliner fishermen who fished in 1985 and not in 1986. The fluctuations in harvest between 1990 and 1991 may have resulted from the opening of the Agat Marina. Although boat trailer counts are taken at this facility the ratio of bottomfish participants to other methods is not known for this area and is expected to be higher than that at the Agana Boat Basin.

**Table G-1. Guam 1991 Creel Survey Composition Of
Allocated Bottomfish Management Species (lbs)**

Species	All Methods	Bottomfishing only
Grouper	2486	1261
Jacks	1705	1296
Lehi	2957	2957
Uku	1469	1469
Ehu	2192	2192
Onaga	0	0
Taape	1251	1252
Yellowtail Kalekale	4981	4981
Opakapaka	898	898
Yelloweye Opakapaka	1180	1180
Kalekale	256	256
Gindai	2498	2498
Emperor	8087	8049
Amberjack	0	0
Total	29962	28289

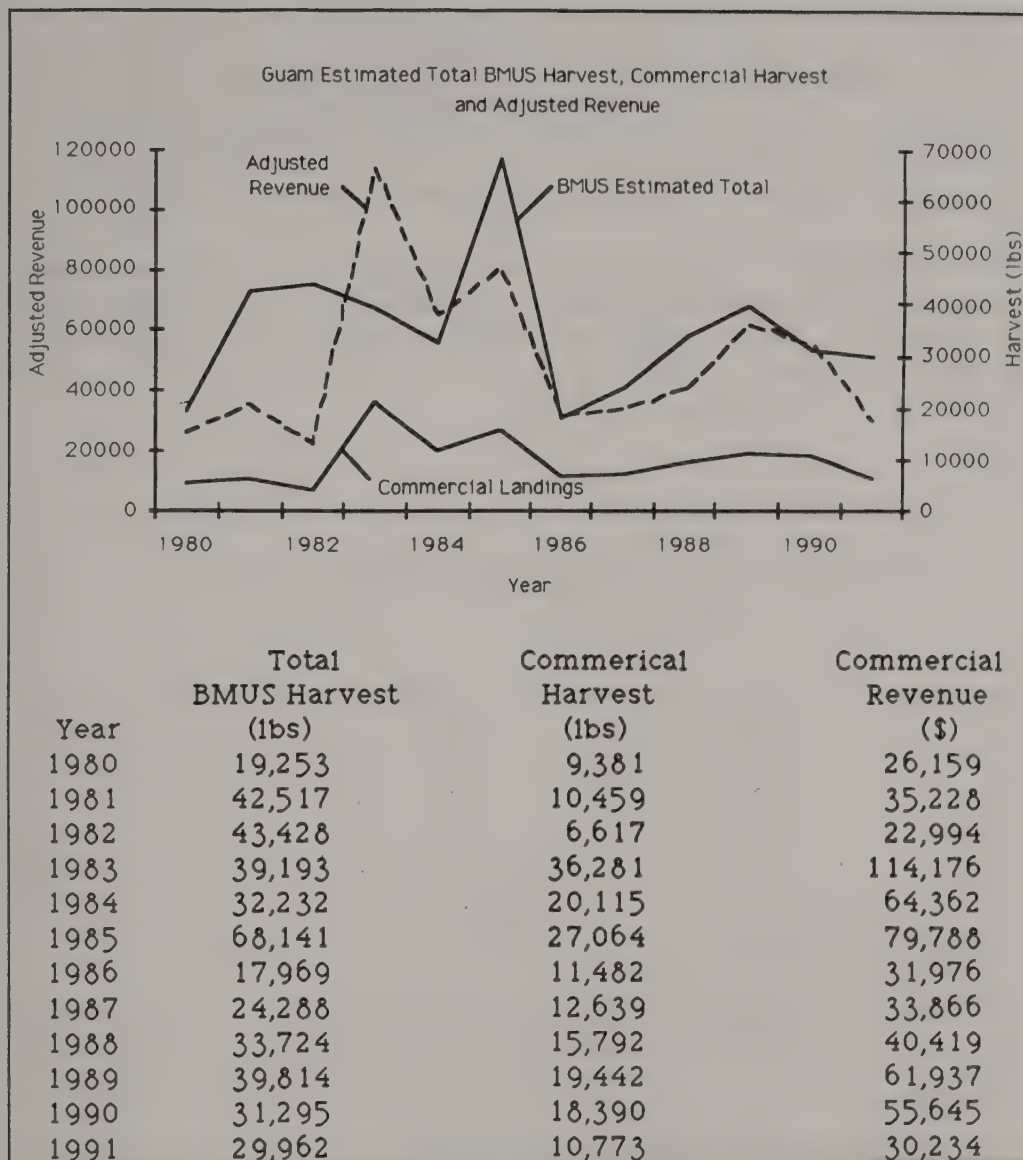


Figure G-2

Source: The estimated total landings are from the DAWR creel survey system, and the commercial data are from the WPACFIN originated commercial landings system.

Calculations: The creel survey data are the same as in the first figure. The total commercial bottomfish landings and revenue for each year were calculated by summing the weight and value fields in the commercial landings data base and then multiplying by an estimated percent coverage expansion factor. This annual expansion factor was subjectively created based on as many factors as possible

depending on the year, including: an analysis of the "disposition of catch" data available from the DAWR offshore creel survey; and evaluation of the fishermen in the fishery and their entry/exit patterns; general "dock side" knowledge of the fishery and the status of marketing conditions and structure; the overall number of records in the data base; and a measure of the best educated guess.

Interpretations: The major fluctuations in the bottomfish fishery are believed to be fishery based, not stock based. This is due to the relatively small size of the bottomfishing fleet and frequent changes in the actual participants.

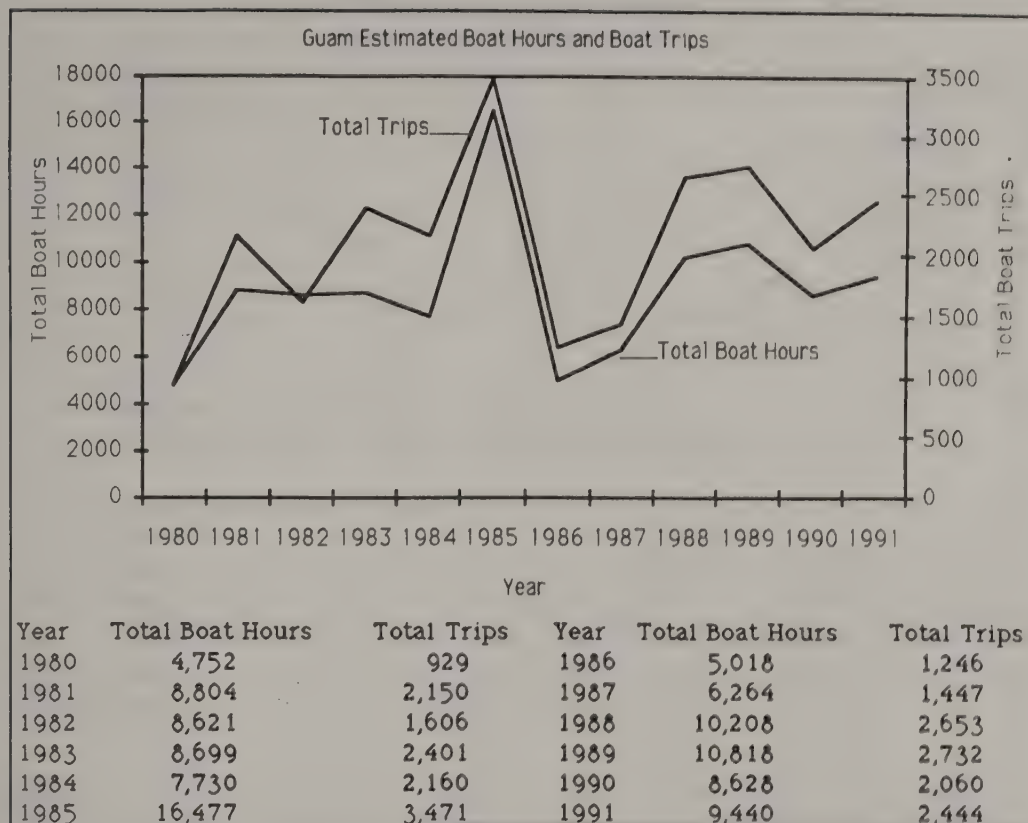


Figure G-3

Source: The DAWR creel survey data for the method bottomfishing.

Calculations: The estimated number of boat trips and boat hours for the bottomfishing method are derived directly from the creel survey expansion algorithms.

Interpretations: These two measures of effort nearly mirror each other and the previous figure for catch. The increase in effort for 1991 is attributed to the shift in participation to Agat Marina. This situation is justification for increasing the survey to incorporate the Agat Marina.

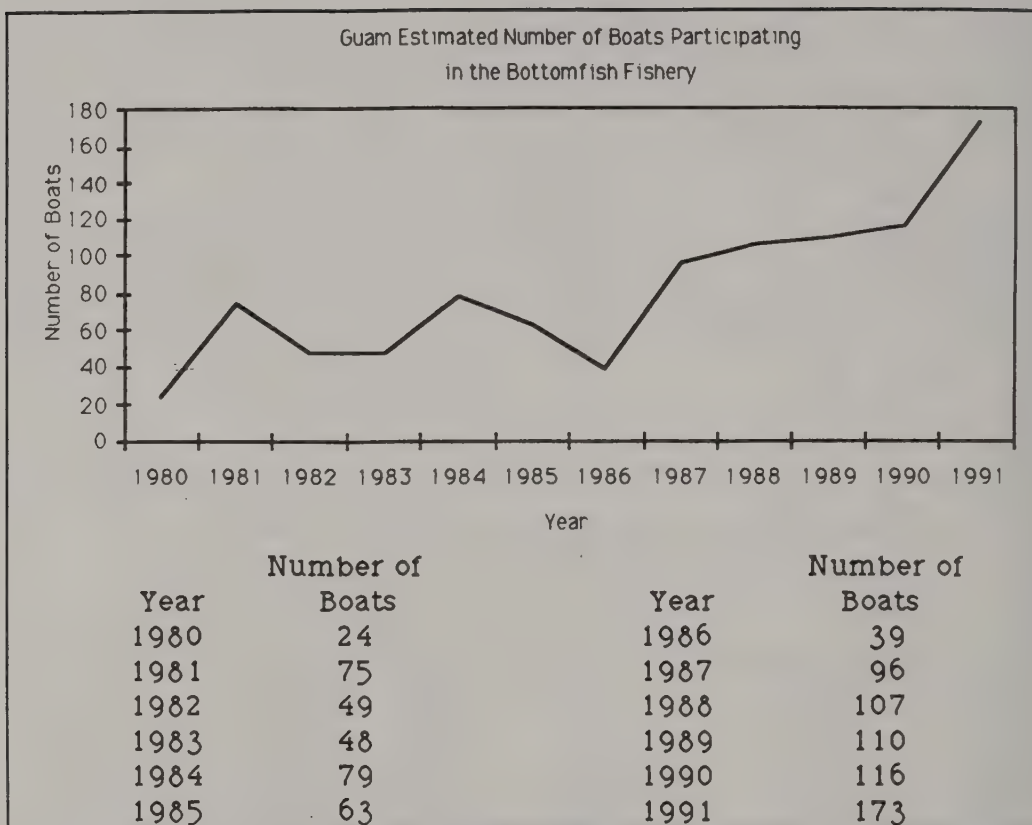


Figure G-4

Source: DAWR offshore creel survey data from Agana Boat Basin

Calculations: The "threshold" C/E model was run a minimum of 15 times per year and the median estimated number of boats is presented above. These numbers should be considered as conservative estimates because boats which use unsurveyed launch sites will never be encountered and because surveys are conducted on only 13 % of the possible days.

Interpretations: Over the last several years the number of boats in this fishery has increased steadily, while the value for 1991 represents almost a 50% increase in participation. This increase can not be fully explained but is expected to be a reflection of the exceptionally calm weather and the healthy economy which has made it possible for more residents to afford boats.

Table G-2. Guam 1990 Commercial Landed Bottomfish
Average Price

Species	Avg. \$/Lb
Bottom fish	2.59
Grouper	2.64
Jacks	2.35
Lehi	3.06
Uku	2.61
Ehu	3.21
Onaga	5.13
Opakapaka	3.20
Kalekale	2.93
Gindai	3.13
Emperor	2.64
Amberjack	
All Bottomfish Species	2.81

Note: The source of this information is different than the values presented for harvest. For this reason the creel survey information did not encounter any onaga harvest for 1991. The commercial landings receipts did however have some sales. The harvest was small and may explain the highest cost per pound

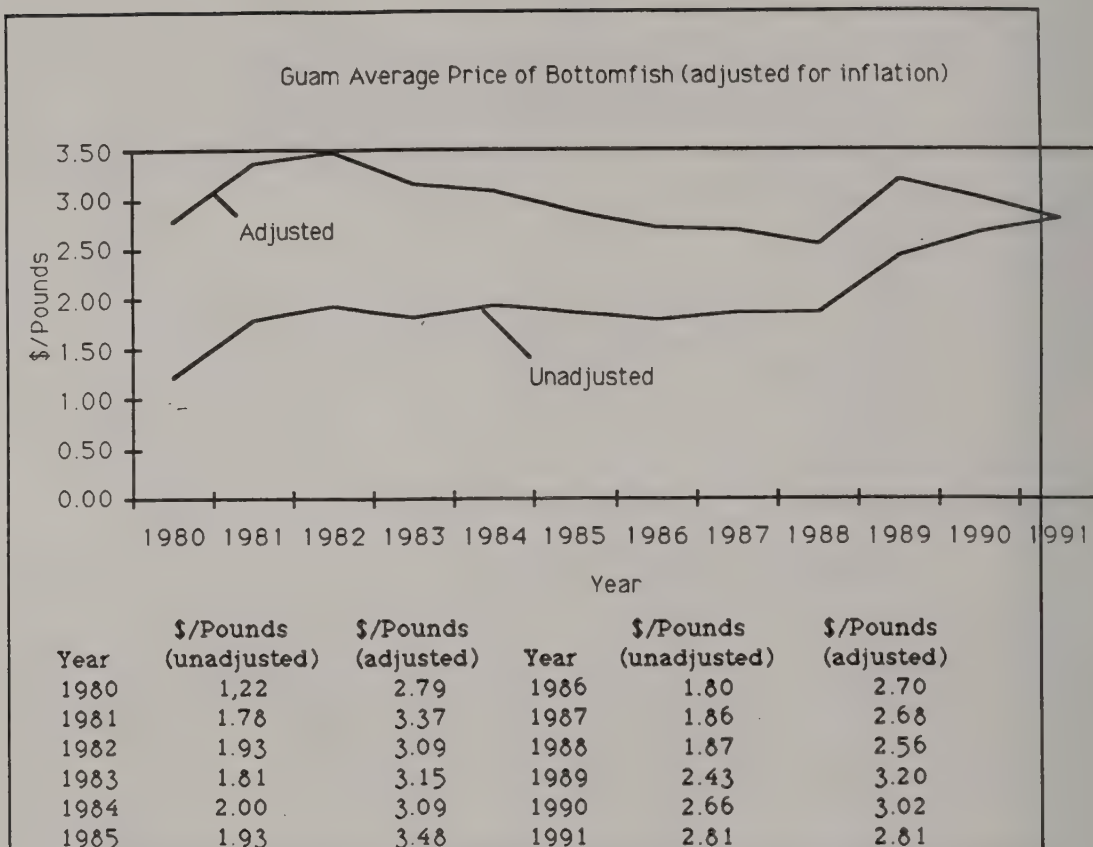


Figure G-5

Source: The commercial landings data from the major wholesaler.

Calculations: The average price of all bottomfish species combined is calculated by dividing the total bottomfish revenue by the sold weight. The inflation adjustment is made by using the Consumer Price Index (CPI) for Guam and establishing the 1991 figure as the base from which to calculate expansion factors for all previous years (e.g. divide the 1991 CPI by the CPI for any given year). Then you multiply the unadjusted average price by this factor to obtain the adjusted average price for the given year.

Interpretations: The adjusted average price for bottomfish has not shown consistent marketing trends. This is expected to have resulted from the seasonal supply of pelagic fish and difficulties in developing the marketing of locally caught fish. In addition both imported fish from other near-by areas and the sale of reject longline caught fish has contributed to the continued marketing problem for local fishermen.

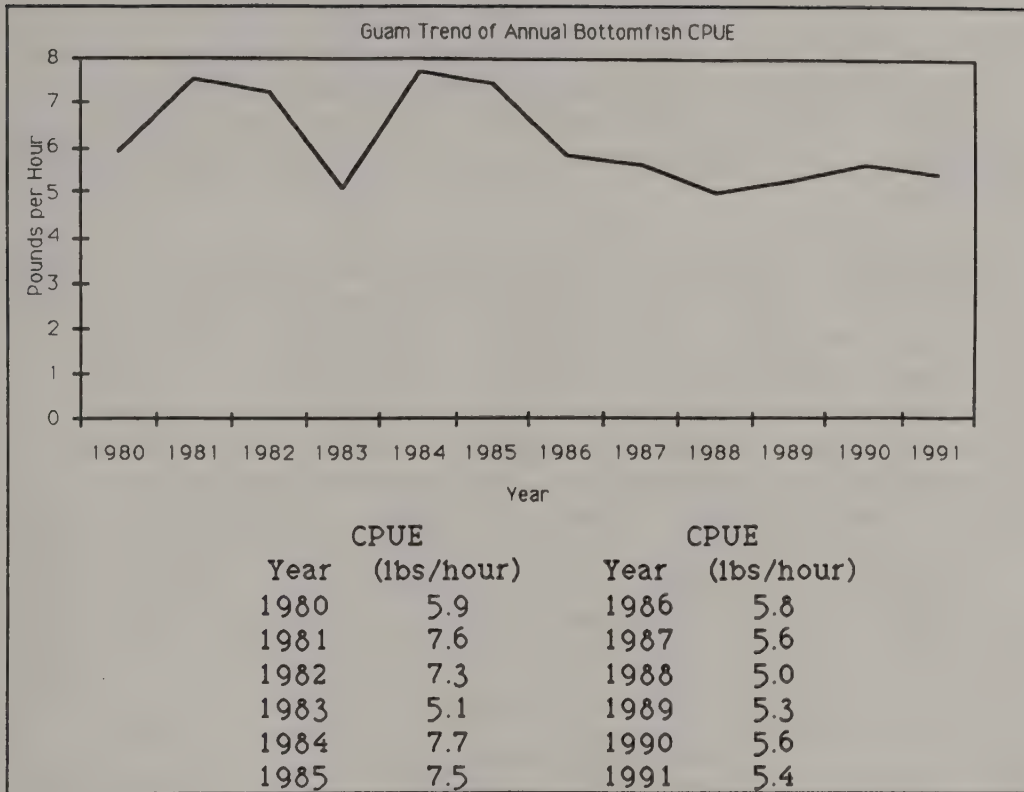


Figure G-6

Source: The DAWR creel survey data for the bottom fishing method.

Calculations: The catch per hour for each bottom fishing trip surveyed is treated as a separate observation in calculating the average CPUE for the bottom fishing method. Basically, the sum of the individual trip CPUE's for surveyed trips is divided by the total number of surveyed trips.

Interpretations: The annual CPUE fluctuates between 5 and 8 pounds per hour, but has been fairly stable for the past 5 years. No problems are indicated by CPUE.

The following comments are for the next eleven figures.

Source: All of the data for the following mean length plots for eleven of the important bottomfish species for which data are available have come from the DAWR Creel sampling program. When fishermen are interviewed, their catch is measured whenever possible.

Calculations: For each year the number of samples for any given species may vary greatly. The mean length was calculated by summing the length for all individuals measured and dividing by the number of individuals.

Interpretations: Although sample size may not be large, the data available do not show any indication in declining mean size of any of the species. Figure G-11 (Opakapaka) exhibits a significant increase in mean length. The 1991 increase is due to the small sample size compounded by a few experienced fishermen participating in the deepwater fishery. Analyses of other indicators are needed to be certain that there indeed is no problem with the fishery.

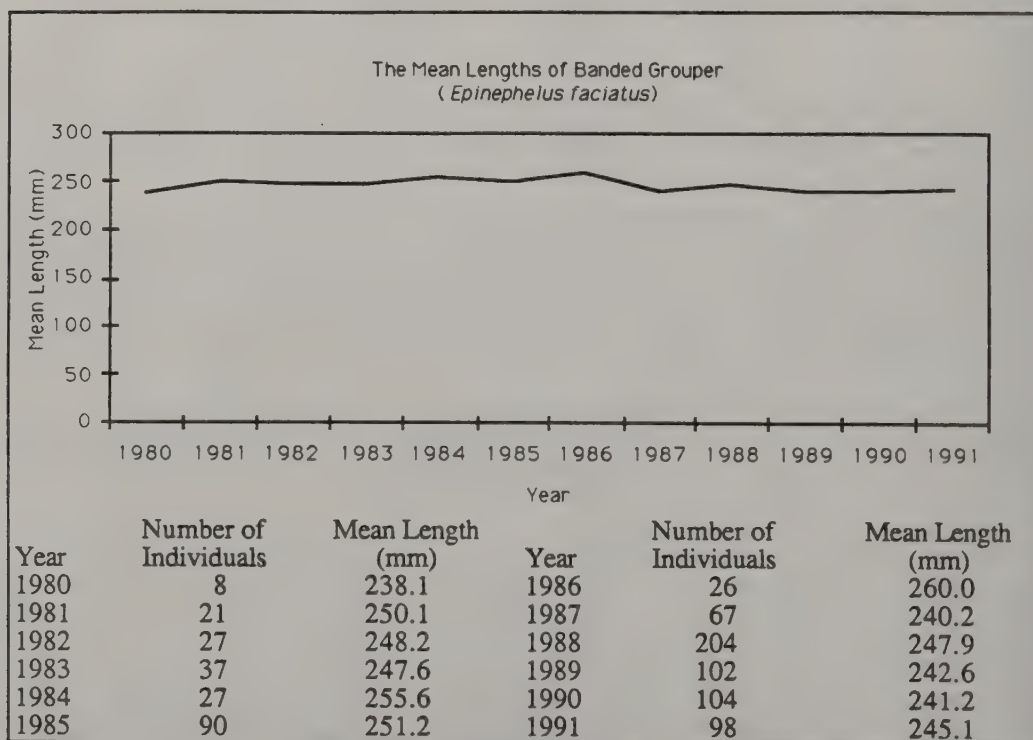


Figure G-7

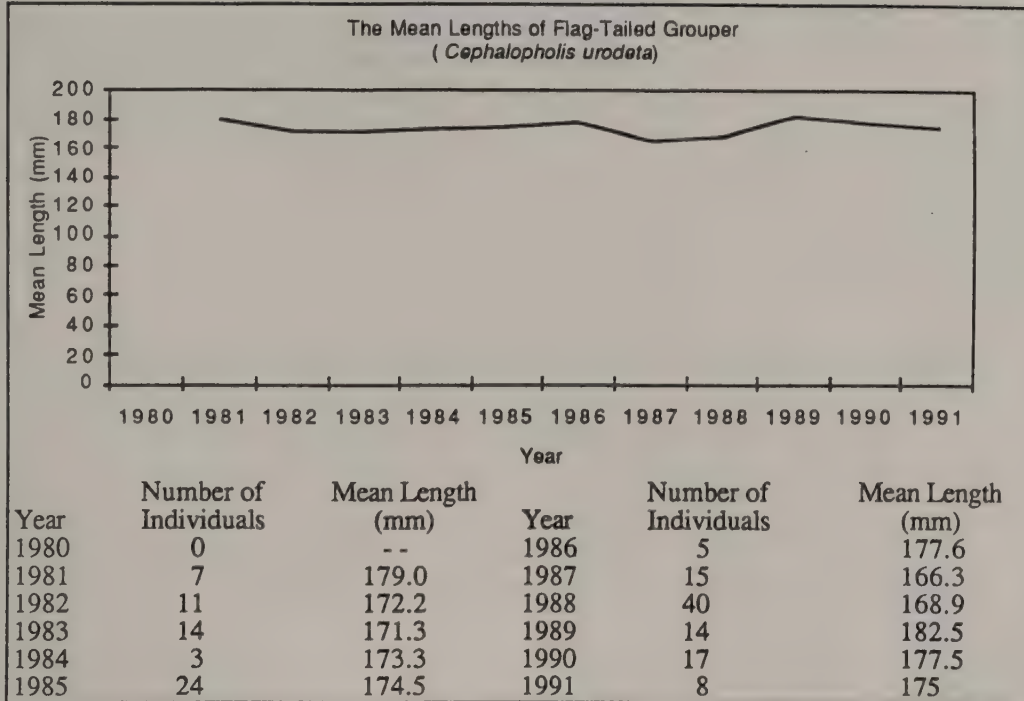


Figure G-8

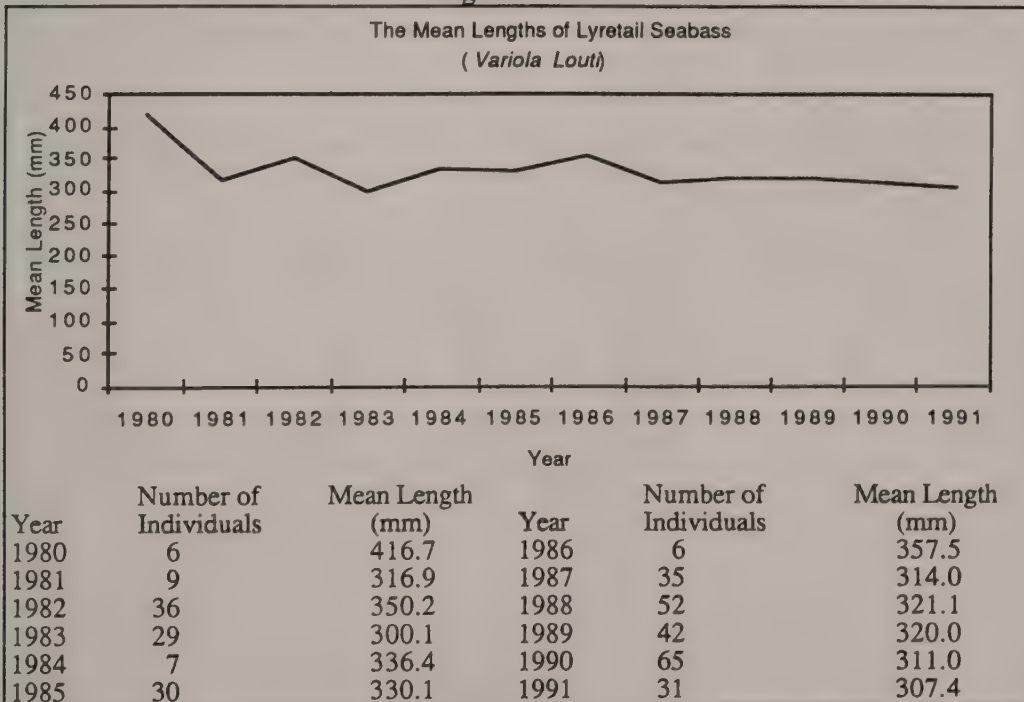


Figure G-9

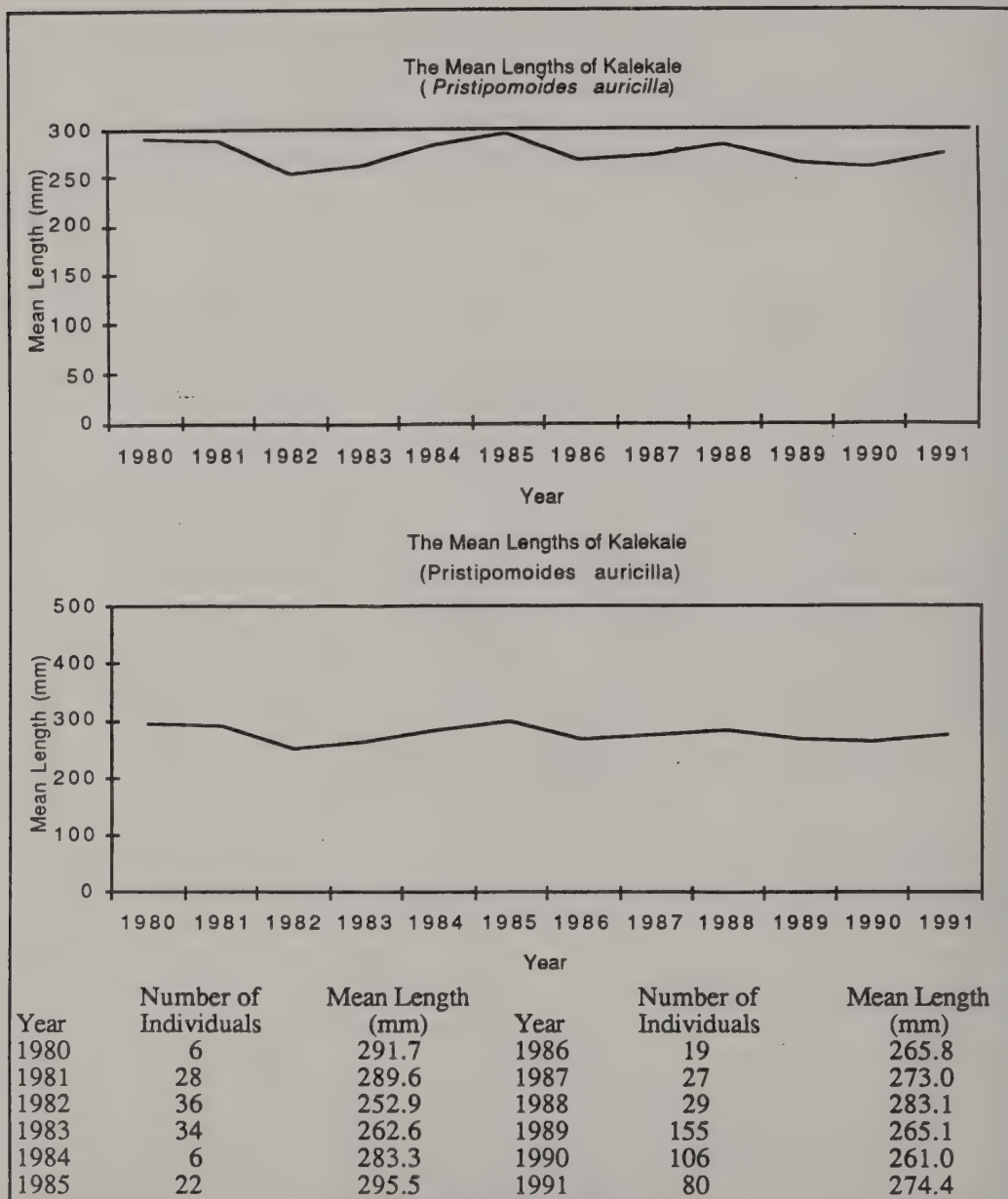


Figure G-10

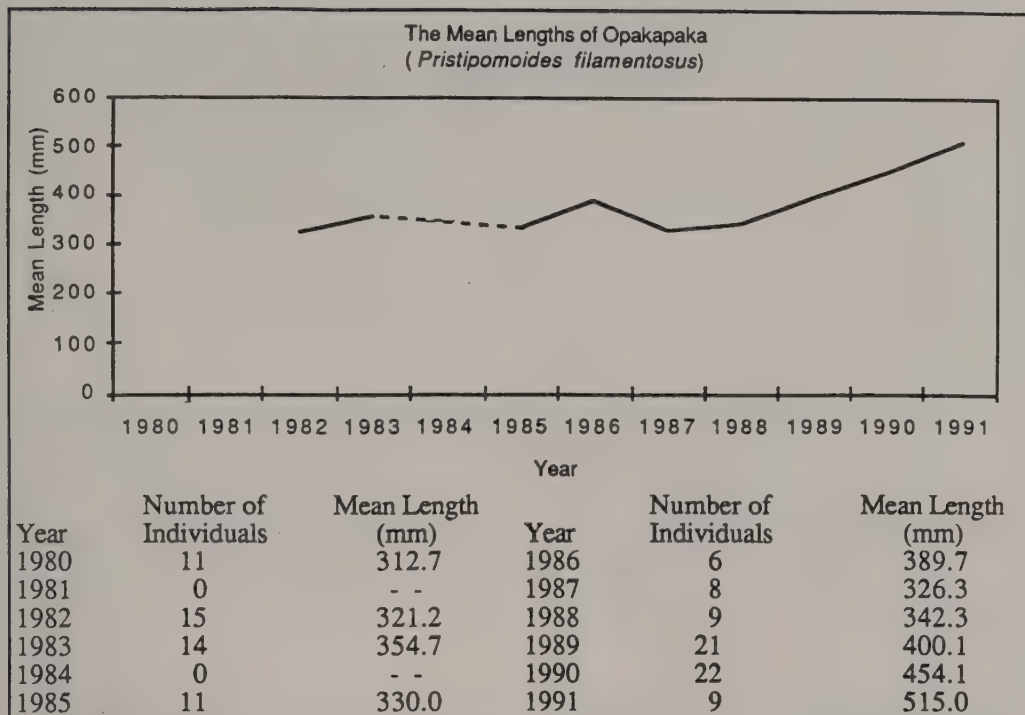


Figure G-11

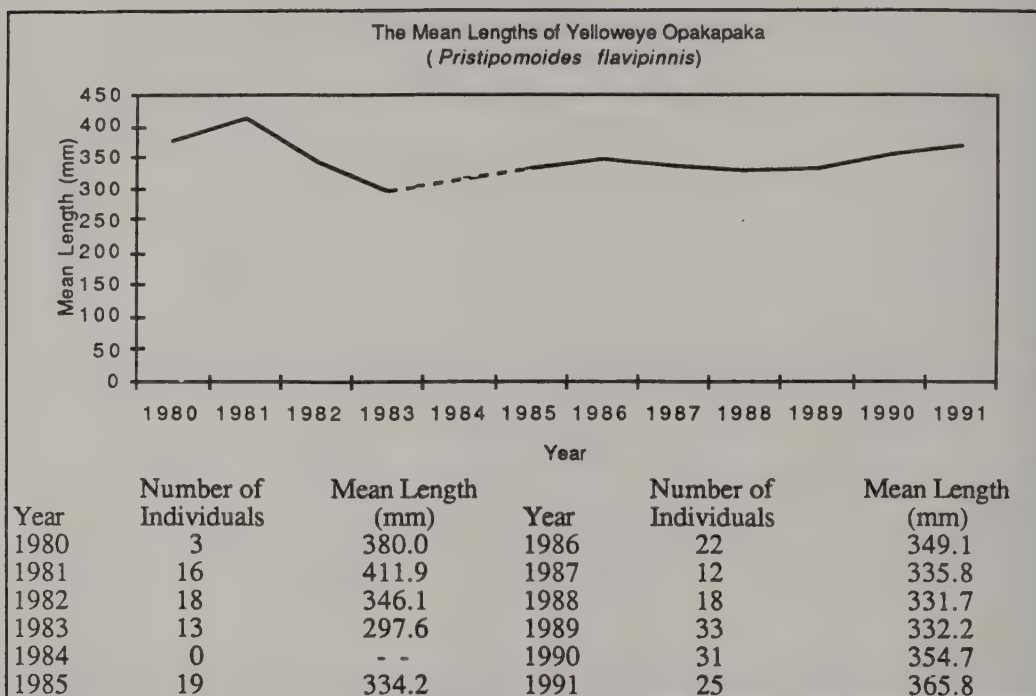


Figure G-12

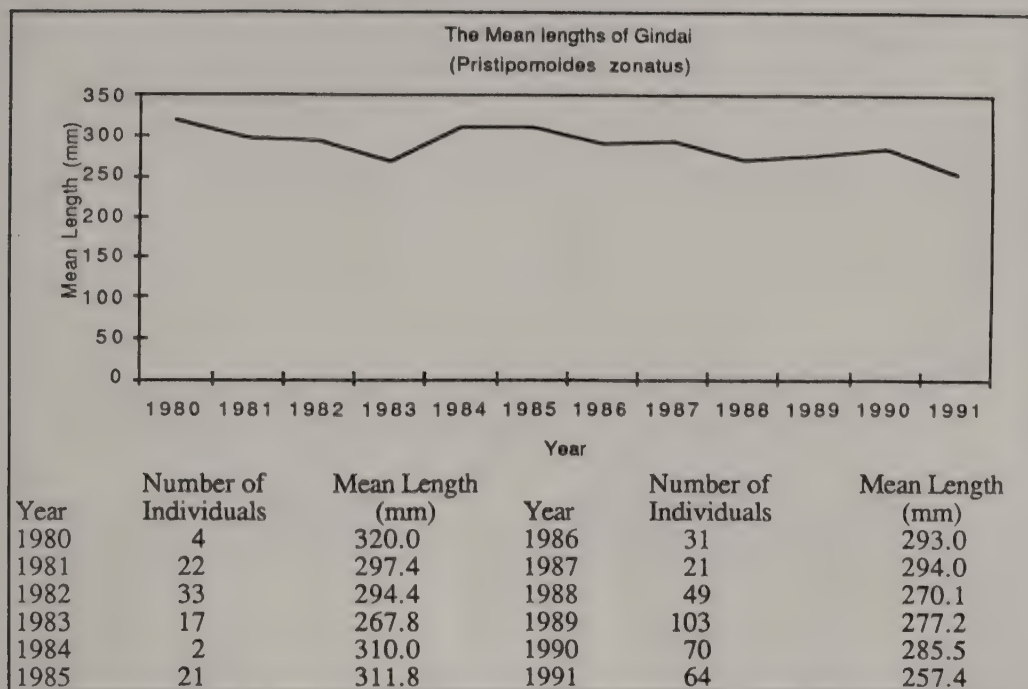


Figure G-13

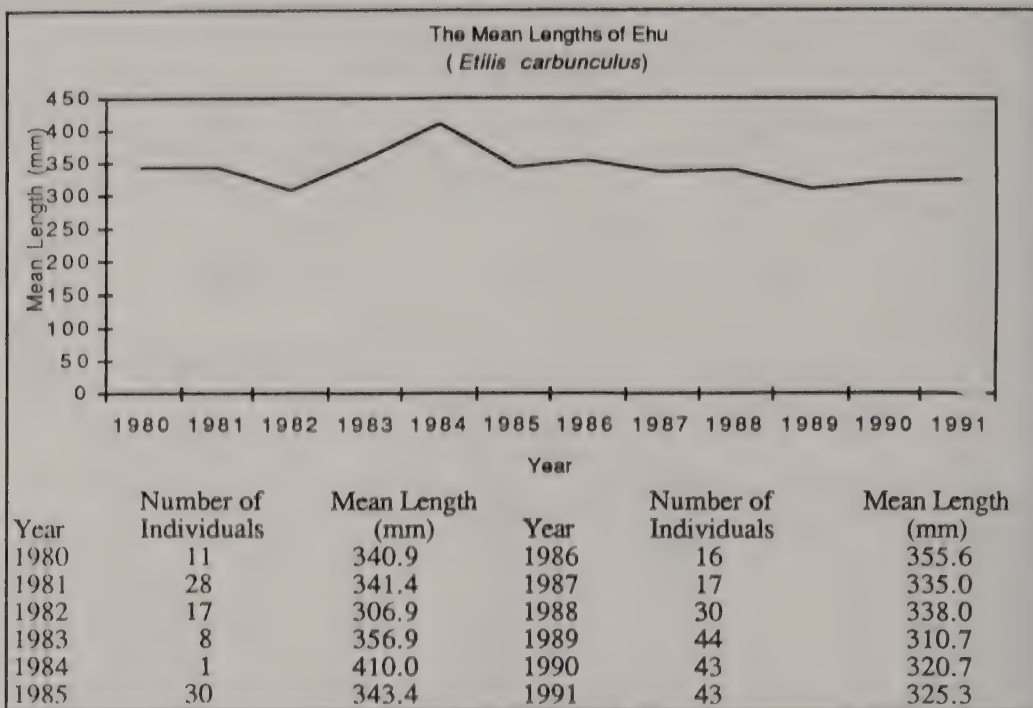


Figure G-14

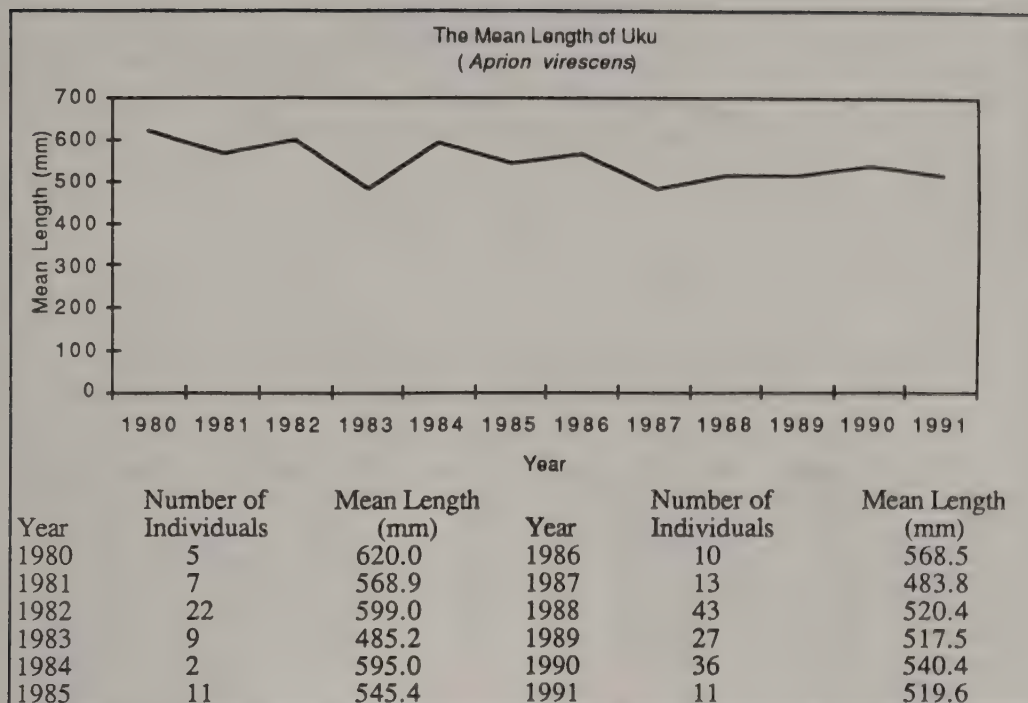


Figure G-15

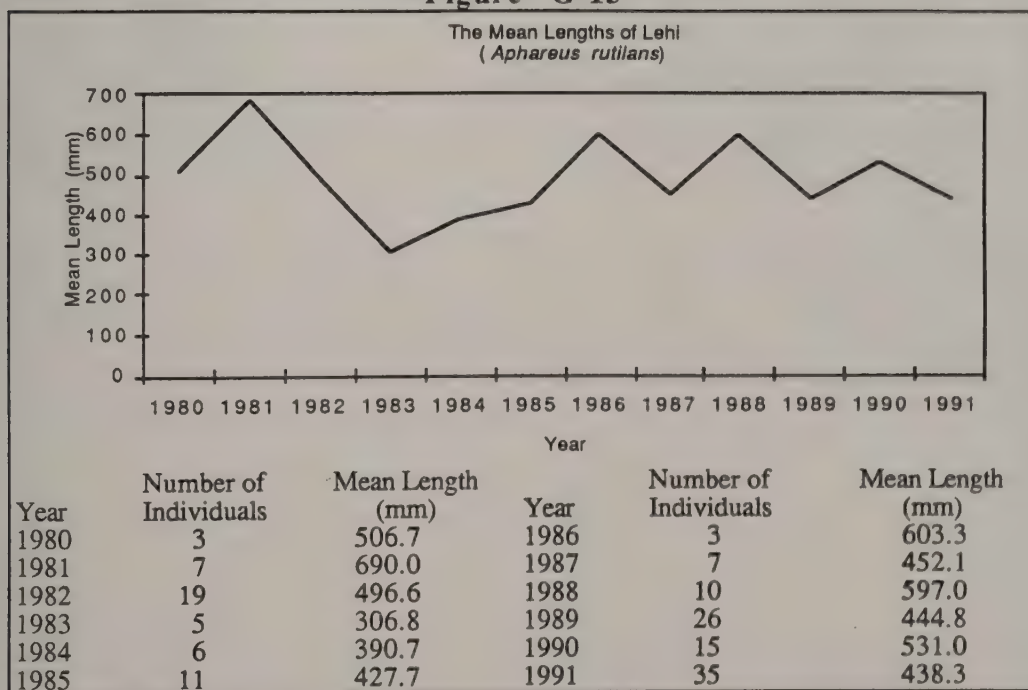


Figure G-16

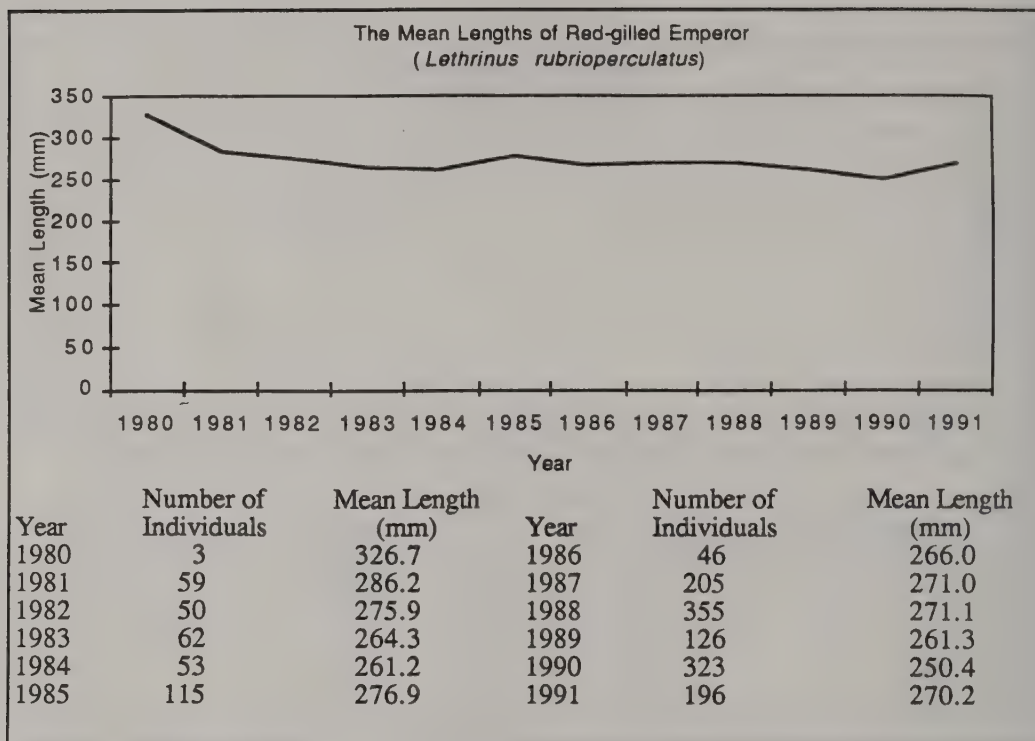


Figure G-17

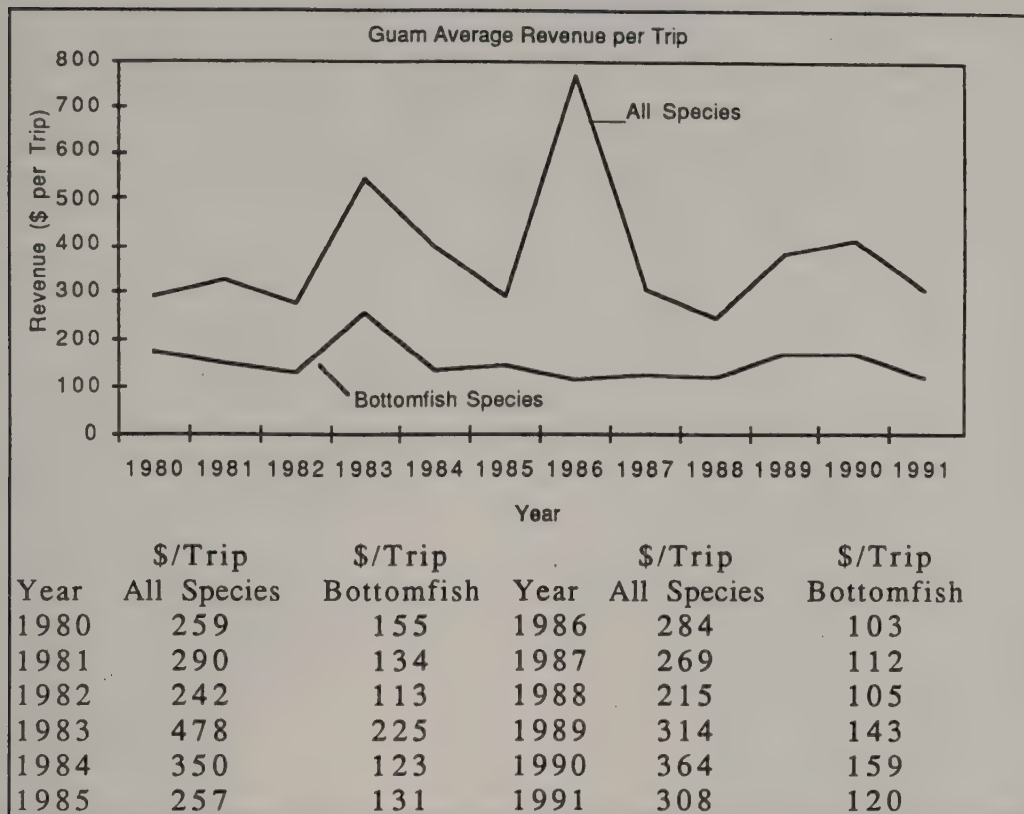


Figure G-18

Source: The commercial landings data from the major wholesaler, the Guam Fisherman's Coop.

Calculations: The average revenue per trip for all species is calculated by summing the revenue of all species sold for any trip which landed bottomfish species, and dividing by the number of trips. The average bottomfish revenue per trips is calculated from those same trips by summing the sales of only bottomfish species and dividing by the number of trips.

Interpretations: The adjusted average revenue per trip does not appear to show any single long term trends.

Recommendations: Guam

1. The red-gilled emperor routinely accounts for a large percentage of Guam's bottomifsh harvest (27% 1991). Spawning Potential Ratio values can not be calculated without an entry CPUE. Again funding is requested to intiate a joint venture project with the CNMI to establish such a baseline.

Hawaii 1991 Descriptors and Indicators

	<u>Page</u>
Introduction	59
 Descriptors	
 <u>Landings Information</u>	
Aggregate Catch	60
Northwestern Hawaiian Islands	
Catch Composition by zone	62
Landings per trip	63
Species Composition by weight	65
Main Hawaiian Islands	
Catch Composition	67
 <u>Effort Information</u>	
Number of Trips	
Total NWHI	68
NWHI by zone	68
MHI	72
 <u>Participation Information</u>	
Number of Vessels	
Total NWHI	70
NWHI by zone	70
MHI	72
 <u>Economic Information</u>	
Aggregate Revenue (market monitoring)	73
Market Revenue	75
Aggregate Revenue, Landings, Prices (HDAR)	77
Aggregate Average Price	80
Average Price by Species	81
 Indicators	
Aggregate CPUE	83
Percent Catch Immature	85
Mean Weight by Species	87
Spawning Potential Ratio	
MHI	89
NWHI	91
Revenue Per Trip	93
Armorhead Research CPUE	94
Armorhead Spawning Potential Ratio	96

Hawaii Bottomfish FMP Annual Report Module, 1991

This module is comprised of information from three programs within the Honolulu Laboratory, NMFS. Kurt Kawamoto and Sam Pooley of the Fishery Monitoring & Economics Program (FMEP) provided information on the Northwestern Hawaiian Islands (NWHI) fishery from information collected by the NMFS shoreside monitoring program. Pooley also provided information on overall market revenue (NWHI, main Hawaiian Islands (MHI), and imports) and price trends based on the same data sources. Summaries of Hawaii Division of Aquatic Resources (HDAR) commercial marine landings statistics for the period 1970-91 were prepared by FMEP computer programming staff. Don Kobayashi of the NMFS Insular Resources Investigation provided detailed analyses of biological indicators, catch per unit effort, and spawning potential ratio information based on both NMFS and HDAR data. Bob Humphreys of the Pelagic Resources Investigation provided material on the seamount groundfish resources based on NOAA vessel Townsend Cromwell research cruises and foreign fishery statistics.

Scientific names for individual species, as well as the species included in "other" categories, are listed in a separate table.

HAWAII'S BOTTOMFISH LANDINGS FOR THE MHI AND NWHI 1984-1991, MAU AND HOOMALU ZONES OF THE NWHI 1989-1991.

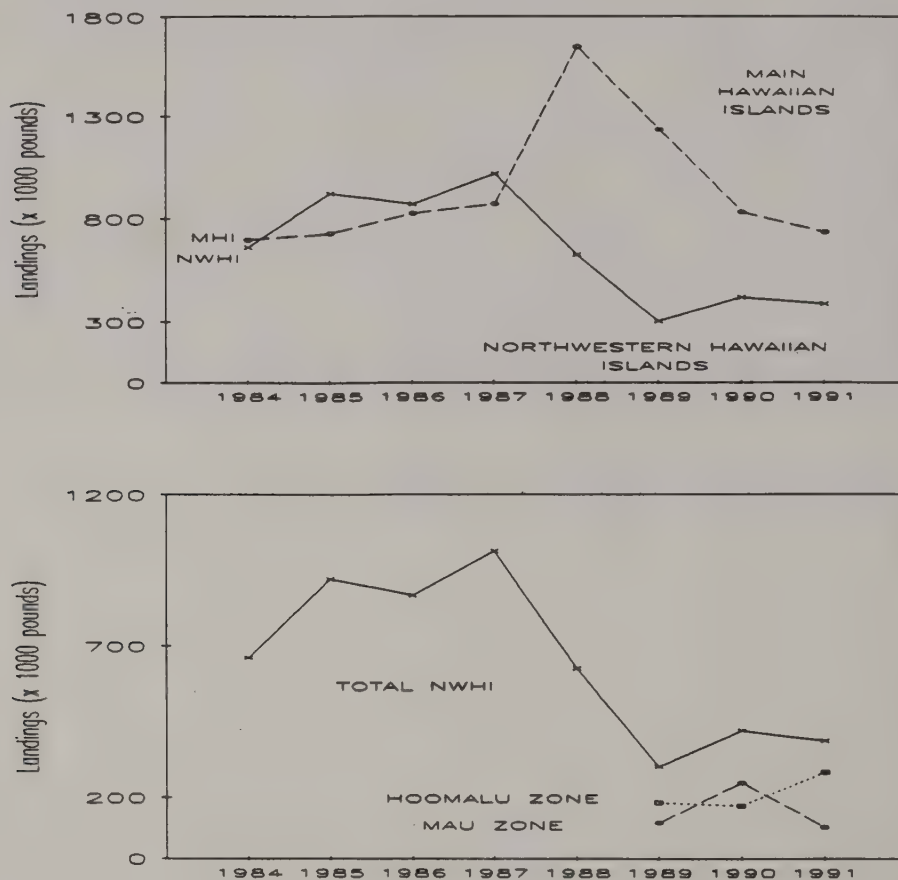


FIGURE H-1

TABULATED VALUES: HAWAII'S BOTTOMFISH LANDINGS NWHI AND MAIN HAWAIIAN ISLANDS, 1984-1991. (THOUSANDS OF POUNDS)

Area	1984	1985	1986	1987	1988	1989	1990	1991 ¹
Mau	NA	NA	NA	NA	NA	118	249	103
Hoomalu	NA	NA	NA	NA	NA	184	173	283
NWHI	661	922	869	1,015	625	303	421	387
TOTAL	661	922	869	1,015	625	303	421	387
MHI	697	727	824	869	1,651	1,234	830	734 ²

¹ Data from combination NMFS and HDAR.

² Preliminary data.

DATA SOURCE:

Landings data for 1984-1990 collected by Honolulu Laboratory's market monitoring program. The 1991 NWHI landings are a combination of NMFS and HDAR data. The 1991 MHI landings are from HDAR.

CALCULATIONS & ADJUSTMENTS:

National Marine Fisheries Service data are presented as an expanded estimate to approximate the total market volume. Market expansion factors are based on a 1979 survey of wholesale markets in Hawaii and on the landing patterns of specific fleets.

The 1991 data set is a combination of the NMFS and the HDAR data which has been extrapolated to account for missing trips.

COMMENTS:

The landings in the NWHI showed an overall decrease in 1991. The large decrease from the Mau zone was not compensated for by the increase in the Hoomalu zone.

The dramatic increase in 1988 MHI landings was mainly due to the volume of uku caught. Subsequent years show a decline in landings mainly due to the decreasing abundance of uku. The 1991 preliminary estimate of the main Hawaiian island landings continues this trend. Landings are down to pre-uku bonanza levels. Landings of other species were down also. The cyclical nature of the bottomfish stocks seem to be a major source of landing fluctuation during the last 3 years.

NWHI BOTTOMFISH CATCH COMPOSITION

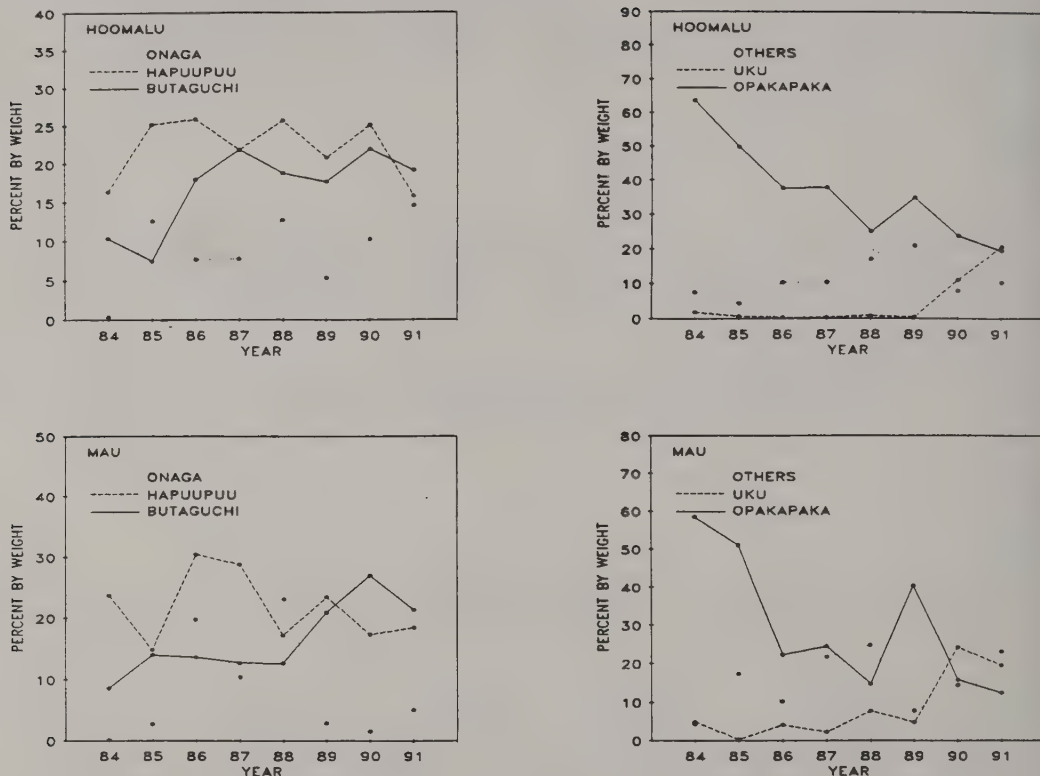


FIGURE H-2

DATA SOURCE:

Catch data collected at the Honolulu auction by the market monitoring program and NMFS vessel interview program.

CALCULATIONS & ADJUSTMENTS:

Catch composition is expressed as percent of total bottomfish weight.

INTERPRETATION:

Mau zone catch composition changed only slightly from 1990, with a small increase in onaga, and decreases in butaguchi, opakapaka, and uku. Hoomalu zone catch composition changed similarly, except for a continuing increase in uku and onaga.

NORTHWESTERN HAWAIIAN ISLANDS BOTTOMFISH MANAGEMENT UNIT SPECIES COMPOSITION OF LANDINGS BY TRIP, MAU AND HOOMALU ZONE, 1989-1991.

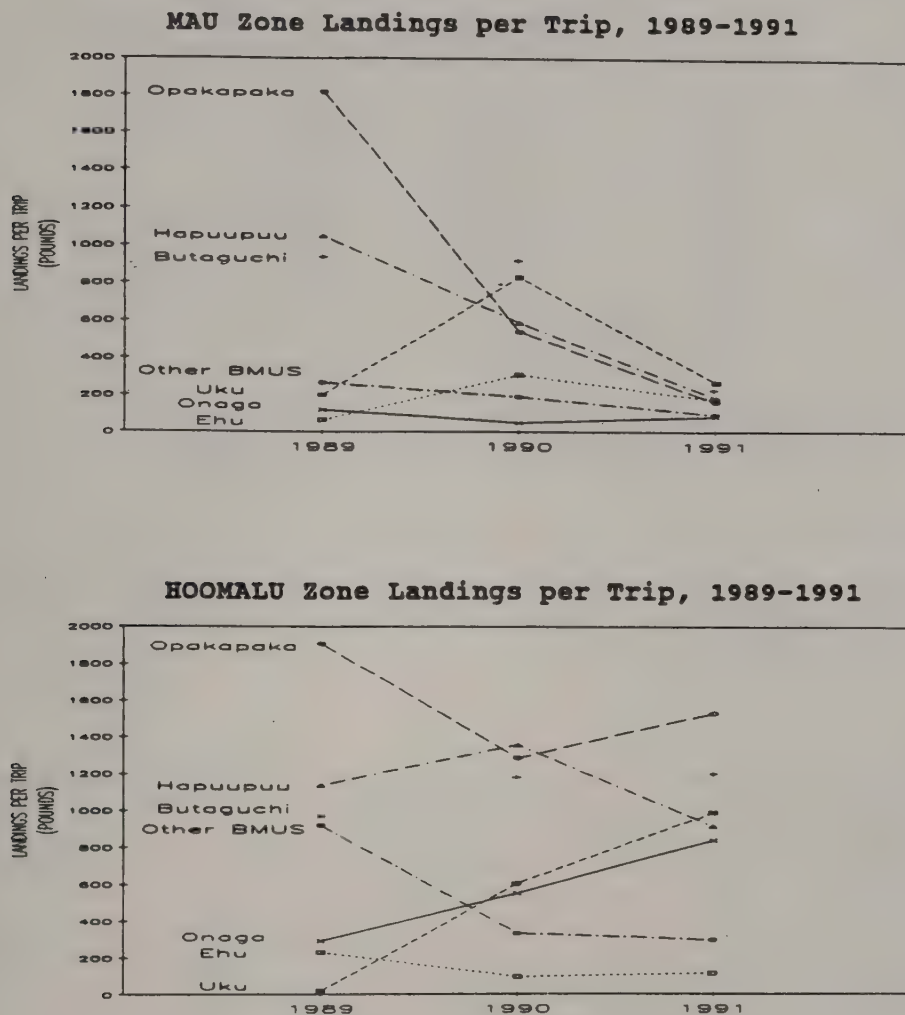


FIGURE H-3

**TABULATED VALUES: NORTHWESTERN HAWAIIAN ISLANDS BOTTOMFISH
MANAGEMENT UNIT SPECIES COMPOSITION OF LANDINGS BY TRIP, MAU AND
HOOMALU ZONE, 1990-1991.**

Species	1990		1991 ¹	
	Mau	Hoomalu	Mau	Hoomalu
Opakapaka	541	1,284	163	1,530
Onaga	49	550	83	837
Ehu	309	94	176	113
Hapuupuu	590	1,357	189	913
Butaguchi	923	1,185	228	1,196
Uku	830	600	266	985
Other BMUS	193	333	94	297
Total per trip	3,435	5,403	1,200	5,873

¹ Data from combination of NMFS and HDAR data sets.

DATA SOURCE:

Landings data collected by Honolulu Laboratory's and HDAR market monitoring program. Data for 1991 from a combination of NMFS and HDAR data.

COMMENTS:

Data not revised for sampling intensity, representativeness, or length of trip. The Mau zone has sustained a large decrease in the BMUS by trip landing volume. This large change is accentuated by the combination data set that was used this year. There were many shorter (trip length), low volume trips that were not being recorded in the past. These additional trips are not landed on Oahu and have not been incorporated into the data set until this year. The Hoomalu zone landings have not changed appreciably due to the fact that the majority of the landings take place on Oahu. Uku landings from the Mau zone have decreased substantially. The Hoomalu zone uku landings are responsible for the increase in landings.

NORTHWESTERN HAWAIIAN ISLANDS BOTTOMFISH MANAGEMENT UNIT SPECIES COMPOSITION OF LANDINGS BY WEIGHT, 1986-1991.

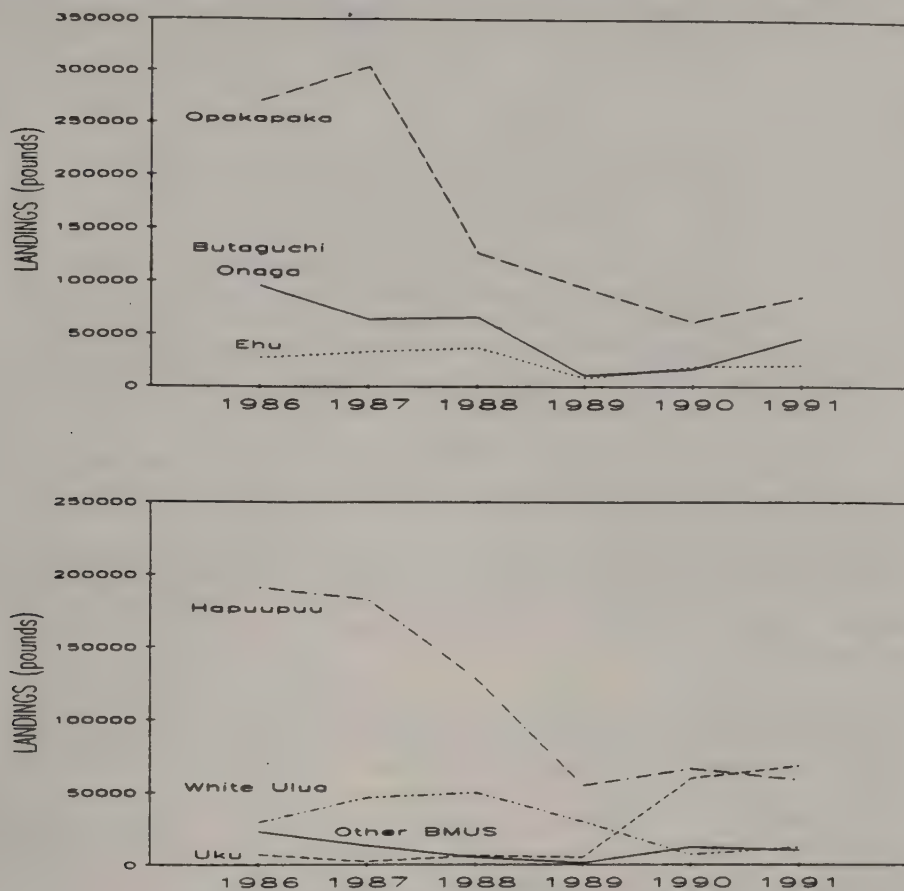


FIGURE H-4

TABULATED VALUES: NORTHWESTERN HAWAIIAN ISLANDS BMUS COMPOSITION OF LANDINGS BY WEIGHT¹, 1986-1991.

Species	1986	1987	1988	1989	1990	1991 ²
Opakapaka	270	304	127	94	62	86
Onaga	96	64	66	11	16	46
Ehu	28	33	37	8	19	20
Hapuupuu	191	183	128	55	66	59
Butaguchi	146	178	91	48	80	75
Uku	7	2	6	5	60	69
White ulua	29	46	50	30	7	12
Other BMUS	23	13	5	1	12	10

¹ Landings = x 1000 pounds.

² Data from a combination of NMFS and HDAR data.

DATA SOURCE:

Landings data collected by Honolulu Laboratory's and HDAR market monitoring program. The 1991 data is from a combination of NMFS and HDAR data.

COMMENTS:

Landings of the targeted "red" fishes (opakapaka and onaga) as well as uku have shown a modest increase.

The trend in the landings over the years have shown that fishermen target on the most abundant or easily caught species of value. When the catch rates of a targeted species declines or another species becomes more economically feasible to take or becomes more abundant for some reason, a switching of target species occurs.

Each species of fish can to a greater or lesser extent be targeted. The relationship between the volume of the target species and the associated by-catch can be seen. For example, in targeting opakapaka the by-catch of butaguchi correspondingly rises. When targeting onaga the landings of ehu rises. When uku is heavily targeted the landings of the deeper water secondary target species such as hapuupuu decreases.

The relationship between white ulua and uku, both shallow water species, has had a inverse correlation. White ulua accounted for the majority of the "Other BMUS" from 1986-89. It is a high volume low value (per pound) catch. During those years uku landings were low although the value per pound was considerably higher than that of white uluas. The abundance of uku precluded any targeting. During 1990-1991 the abundance of uku increased dramatically such that it became feasible to target. Targeting was switched to some extent from the "red fish" and white ulua was not actively targeted.

MHI BOTTOMFISH CATCH COMPOSITION

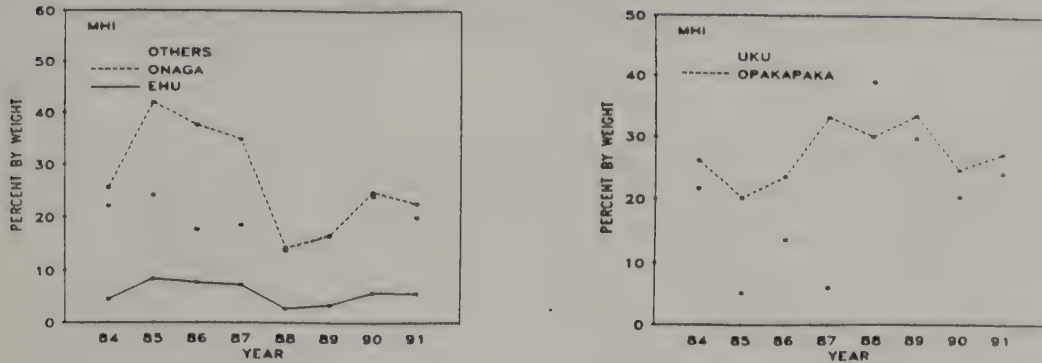


FIGURE H-5

DATA SOURCE:

Catch data collected at the Honolulu auction by the market monitoring program.

CALCULATIONS & ADJUSTMENTS:

Catch composition is expressed as percent of total bottomfish weight.

INTERPRETATION:

The percentage of opakapaka and uku in the MHI catch composition has increased in 1991. Ehu has remained relatively stable, while onaga and other species have declined.

**NUMBER OF TRIPS MADE BY THE NORTHWESTERN HAWAIIAN ISLANDS
BOTTOMFISH FLEET 1984-1991, MAU AND HOOMALU ZONE 1988-1991.**

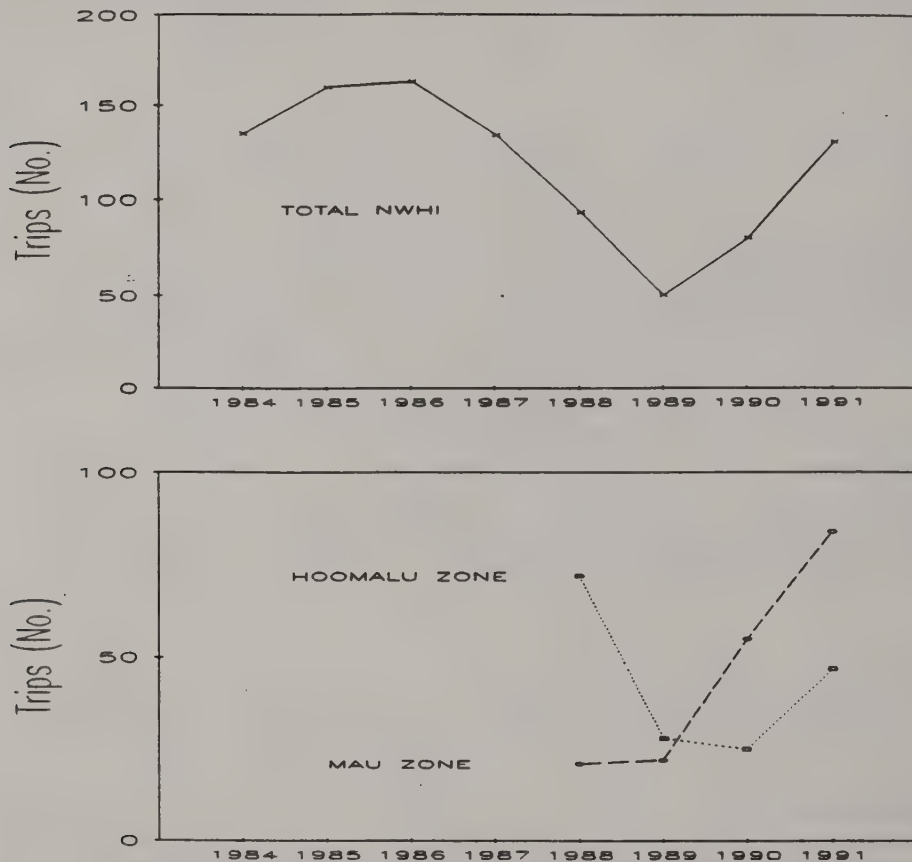


FIGURE H-6

TABULATED VALUES: NUMBER OF TRIPS MADE BY THE NORTHWESTERN HAWAIIAN ISLANDS BOTTOMFISH FLEET 1984-1991, MAU AND HOOMALU ZONE 1988-1991.

Area	1984	1985	1986	1987	1988	1989	1990	1991 ¹
Mau	NA	NA	NA	NA	21	22	55	84
Hoomalu	NA	NA	NA	NA	72	28	25	47
Total	135	160	163	134	93	50	80	131

¹ Based on combined NMFS and HDAR data.

DATA SOURCE:

Trip data collected by Honolulu Laboratory's and HDAR market monitoring program. The 1991 data is the result of a combination of NMFS and HDAR data sets.

COMMENTS:

The limited entry program started in 1989. The number of Mau zone entrants increased due to the limited access into the Hoomalu zone. In 1991 the Mau zone shows a trip count increase which is due to the new combined data set used this year. The combined data set includes additional vessels that fish from Kauai. These vessels were not represented in previous years. These vessels are generally smaller in size and make more trips of shorter duration than vessels home ported on Oahu.

NUMBER OF VESSELS IN THE NORTHWESTERN HAWAIIAN ISLANDS BOTTOMFISH FLEET 1984-1991, MAU AND HOOMALU ZONE 1988-1991.

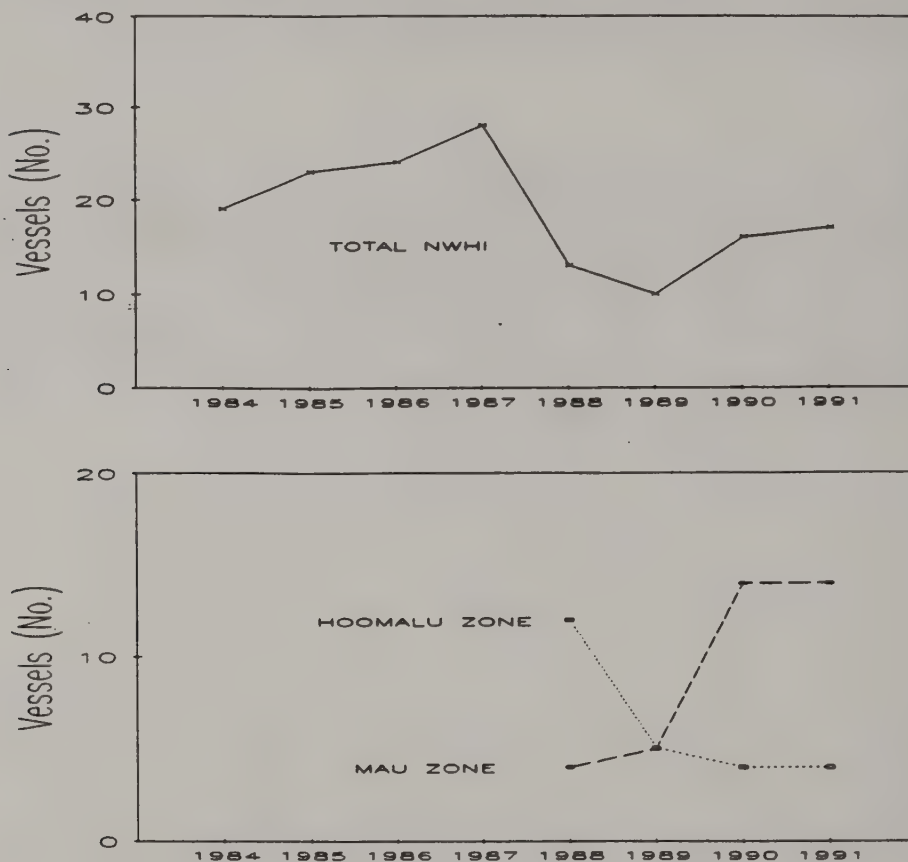


FIGURE H-7

TABULATED VALUES: NUMBER OF VESSELS IN THE NORTHWESTERN HAWAIIAN ISLANDS BOTTOMFISH FLEET 1984-1991, MAU AND HOOMALU ZONE 1988-1991.

Area	1984	1985	1986	1987	1988	1989	1990	1991 ¹
Mau	NA	NA	NA	NA	4	5	14	14
Hoomalu	NA	NA	NA	NA	12	5	5	4
Total ²	19	23	24	28	13	10	16	17

¹ Based on a combination NMFS and HDAR data set.

² Total may not match sum of areas due to vessel participation in multiple areas.

Vessel participation data through 1990 collected by Honolulu Laboratory's and HDAR's market monitoring program. The 1991 data is the result of a combination of NMFS and HDAR data sets.

COMMENTS:

The limited entry program started in 1989 thereby decreasing the number of participants into the Hoomalu zone fishery. The 1990 increase in the Mau zone vessel participation is a result of the limited entry plan forcing all new entrants into the Mau zone. In 1991 the level of activity in the Mau zone remains high.

The 1991 number of active vessels is based on a combination of NMFS and HDAR data and represents four additional vessels that would have otherwise been missed using only NMFS data. These additional vessels are Mau zone participants.

BOTTOMFISHING TRIPS & VESSELS IN MAIN HAWAIIAN ISLANDS

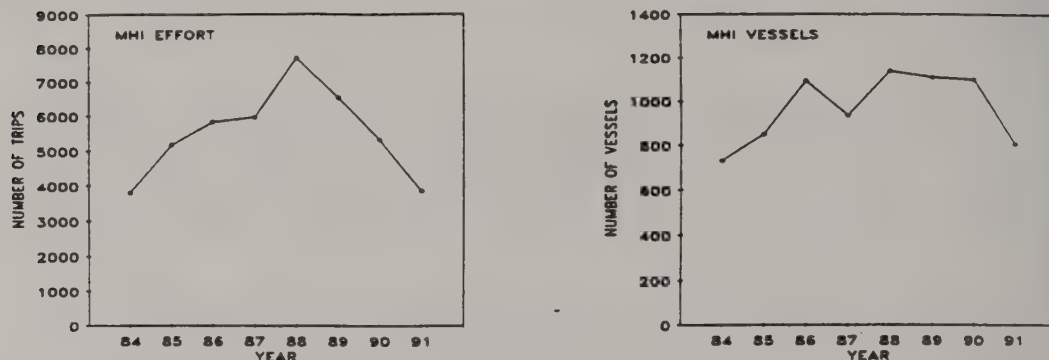


FIGURE H-8

DATA SOURCE:

Fishing effort and vessels based on Honolulu auction data collected by the NMFS market monitoring program.

CALCULATIONS & ADJUSTMENTS:

MHI trips and vessels estimated from total adjusted MHI bottomfish landings, mean catch per trip, and mean total landing per year per boat. Trip data were screened to only include trips where at least 90% of the catch by weight was bottomfish.

INTERPRETATION:

MHI effort and participation continue to decrease from 1988 peak values.

TABULATED VALUES:

YEAR	MHI	
	TRIPS	VESSELS
1984	3787	731
1985	5153	851
1986	5813	1094
1987	5951	934
1988	7707	1140
1989	6522	1111
1990	5318	1101
1991	3830	809

HAWAII BOTTOMFISH DOMESTIC REVENUE, 1984-91, NMFS ESTIMATES. NOMINAL (ACTUAL) AND INFLATION-ADJUSTED (1991 BASE YEAR) REVENUE FROM HAWAII LANDINGS.

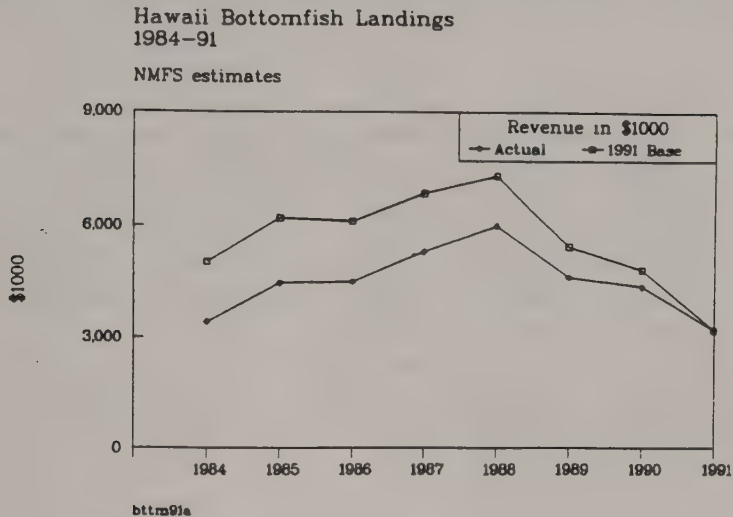


FIGURE H-9

DATA SOURCE:

Data collected by NMFS shoreside monitoring program.

CALCULATIONS & ADJUSTMENTS:

Estimates for 1984-90 compiled from extrapolation of NMFS market samples. Estimate for 1991 compiled by adjusting NMFS 1990 estimate of total pounds caught by the rate of growth in landings of individual species from HDAR data, 1990 to 1991. Revenue was then calculated from NMFS price estimates. Prices are at the wholesale purchase level.

Revenue is adjusted for inflation by multiplying each year's nominal (actual) revenue by the ratio of the 1991 Honolulu consumer price index (CPI) to each year's CPI. This adjusts early year revenues to the same purchasing power basis as current year revenues.

INTERPRETATION:

The time-series shows a dramatic decline in overall revenue from 1988, caused by a decline in overall landings (see interpretation of landings decline elsewhere in this report).

TABULATED VALUES:

Hawaii bottomfish nominal (actual) revenue, 1984-91.

	1984	1985	1986	1987	1988	1989	1990	
Hawaii	3,421	4,461	4,500	5,300	6,000	4,617	4,370	3
NWHI	1356	2086	1,900	2,300	1,500	756	1,070	1
MHI	2064	2374	2,600	3,000	4,500	3,861	3,300	2
Imports	340	651	760	1,140	790	1,644	1,130	1
Total	3,671	5,187	5,260	6,440	6,790	6,261	5,500	4

Inflation-adjusted revenue to 1991 base year by current year Honolulu consumer price index (CPI).

	1984	1985	1986	1987	1988	1989	1990	
Hawaii	5,032	6,201	6,118	6,858	7,328	5,436	4,814	3
NWHI	1,996	2,900	2,583	2,976	1,832	890	1,179	1
MHI	3,037	3,300	3,535	3,882	5,496	4,546	3,635	2
Imports	500	905	1,033	1,475	965	1,935	1,245	1
Total	5,401	7,211	7,151	8,333	8,293	7,371	6,059	4
CPI	284.8	301.4	308.2	323.8	343.05	355.9	380.35	

HAWAII'S BOTTOMFISH MARKET REVENUE, 1984-1991.

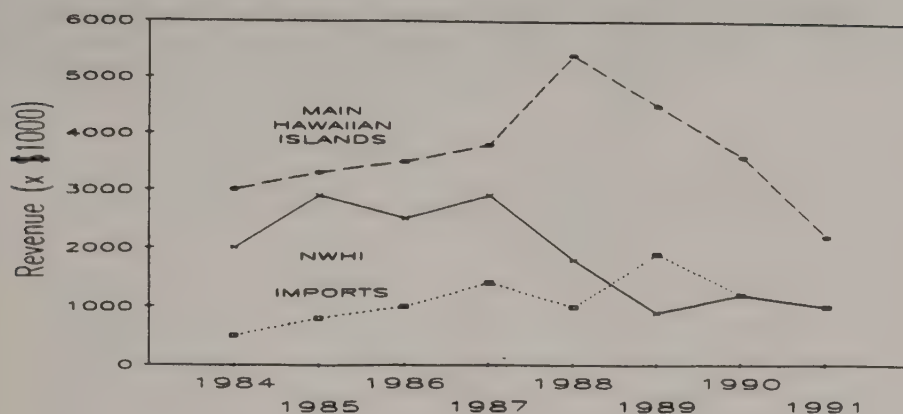


FIGURE H-10

TABULATED VALUES: HAWAII'S BOTTOMFISH MARKET REVENUE¹, 1984-1991.

Area	1984	1985	1986	1987	1988	1989	1990	1991
HAWAII	5,000	6,200	6,000	6,700	7,300	5,400	4,800	3,200
NWHI	2,000	2,900	2,500	2,900	1,800	900	1,200	1,000
MHI	3,000	3,300	3,500	3,800	5,400	4,500	3,600	2,200 ²
IMPORTS	500	800	1,000	1,400	1,000	1,900	1,200	1,000
TOTAL	5,500	7,000	7,000	8,100	8,300	7,300	6,000	4,200

¹ REVENUE = X \$1000, inflation-adjusted to 1991 levels.

² Preliminary data.

DATA SOURCE:

NWHI revenue data collected by Honolulu Laboratory's market monitoring program. Import revenue data from 1991 NMFS Market News. Preliminary MHI revenue data from extrapolated HDAR data.

CALCULATIONS AND ADJUSTMENTS:

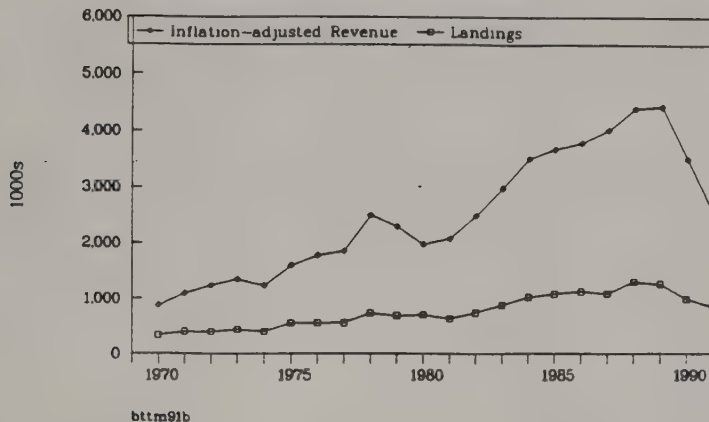
National Marine Fisheries Service data are presented as an expanded estimate to approximate the total market volume represented by our monitoring sites. Revenue values are inflation-adjusted to 1991 values by the Honolulu consumer price index. NWHI values for 1984-1985 derived from MHI price levels.

COMMENTS:

The general decline in revenue values since 1987 mirror the decline in the landings. The prices of bottomfish species have remained stable until 1991 when a slight decline was observed.

HAWAII BOTTOMFISH LANDINGS, REVENUE, AND AVERAGE PRICE, 1970-91.
HAWAII DIVISION OF AQUATIC RESOURCES (HDAR) DATA COMPILED BY NMFS.
INFLATION-ADJUSTED TO 1991 BASE YEAR.

Hawaii bottomfish fishery
 1970-1991
 Hawaii Division of Aquatic Resources data



Hawaii bottomfish fishery
 1970-1991
 Hawaii Division of Aquatic Resources data

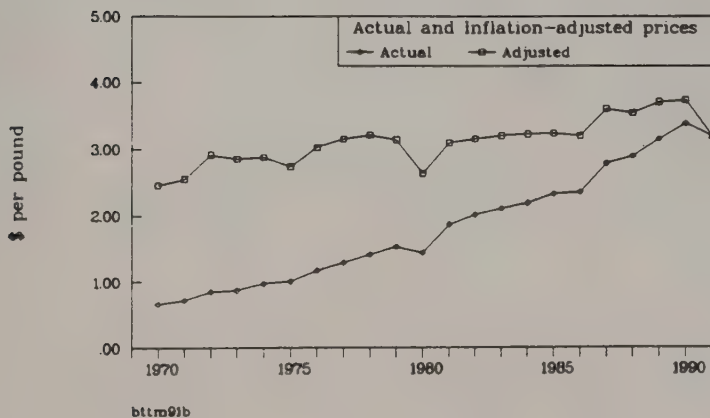


FIGURE H-11

TABULATED VALUES: HAWAII BOTTOMFISH LANDINGS, REVENUE, AND AVERAGE PRICE, 1970-91.

Year	Landings (1000 Pounds)	Actual Revenue (\$1000)	Inflation- adjusted Revenue	Actual Price	Inflation- adjusted Price	Honolulu Consumer Price Index
1970	339	239	877	0.67	2.46	114
1971	406	310	1,092	0.72	2.55	119
1972	402	363	1,239	0.86	2.92	123
1973	446	413	1,349	0.88	2.86	128
1974	405	417	1,231	0.98	2.88	142
1975	555	591	1,598	1.01	2.74	155
1976	557	692	1,781	1.18	3.03	163
1977	560	762	1,858	1.29	3.15	172
1978	738	1,098	2,499	1.41	3.21	184
1979	692	1,120	2,295	1.53	3.14	205
1980	710	1,077	1,973	1.44	2.64	229
1981	637	1,253	2,077	1.86	3.09	253
1982	746	1,587	2,480	2.02	3.15	268
1983	880	1,956	2,971	2.11	3.20	276
1984	1,028	2,376	3,496	2.19	3.22	285
1985	1,079	2,646	3,678	2.33	3.24	301
1986	1,121	2,791	3,794	2.35	3.20	308
1987	1,087	3,103	4,015	2.78	3.60	324
1988	1,299	3,600	4,397	2.90	3.54	343
1989	1,261	3,764	4,431	3.15	3.71	356
1990	992	3,174	3,497	3.39	3.74	380
1991	848	2,534	2,534	3.20	3.20	419

DATA SOURCE:

Data from HDAR commercial marine landings reports, compiled by NMFS.

CALCULATIONS & ADJUSTMENTS:

HDAR landings data for 1991 are preliminary. The HDAR stated figures are adjusted upwards by 5% upwards to account for incomplete reporting.

Revenue represents ex-vessel revenue (wholesale purchase price less brokerage fees). Inflation-adjusted revenue and price is constructed by multiplying each year's revenue and price by the ratio of the 1991 Honolulu consumer price index (CPI) to each year's CPI.

INTERPRETATION:

The total volume of landings rose by over three fold from the early 1970s to the late 1980s, but have declined substantially in recent years (see interpretation of more detailed landings information elsewhere in this report). Inflation-adjusted revenue rose even more strongly, due to increased market demand and product promotion. Inflation-adjusted prices rose by approximately 30% over the period. Prices fell in 1991, as explained elsewhere in this report.

HAWAII BOTTOMFISH AVERAGE MARKET PRICE, BY FISHING LOCATION, 1987-1991. NMFS ESTIMATE. ADJUSTED FOR INFLATION TO 1991 BASE YEAR.

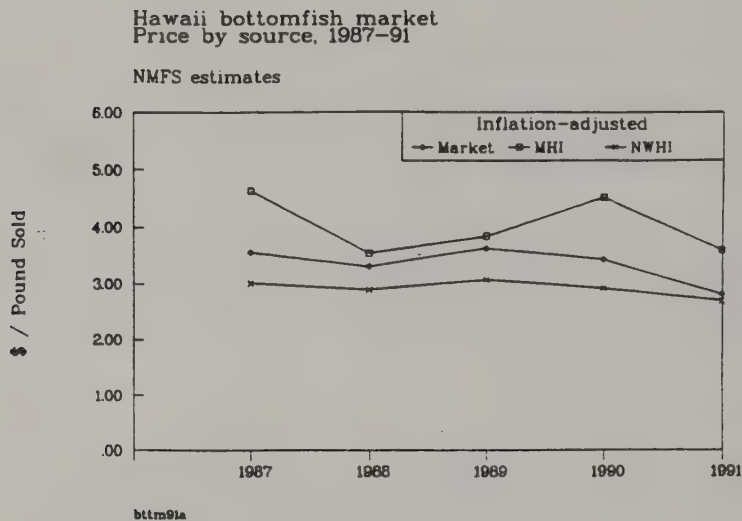


FIGURE H-12

DATA SOURCE:

Data from NMFS shoreside monitoring and U.S. FDA import samples.

CALCULATIONS & ADJUSTMENTS:

Price per pound (whole weight) adjusted for inflation for all bottomfish landings combined.

INTERPRETATION:

The bottomfish average price time-series shows a slight decline over the period, with a particular drop in MHI prices in 1991. Aggregate prices may disguise changes in prices for individual species due to changes in the species composition of the aggregate catch.

HAWAII BOTTOMFISH PRICES BY SPECIES, 1987-1991.

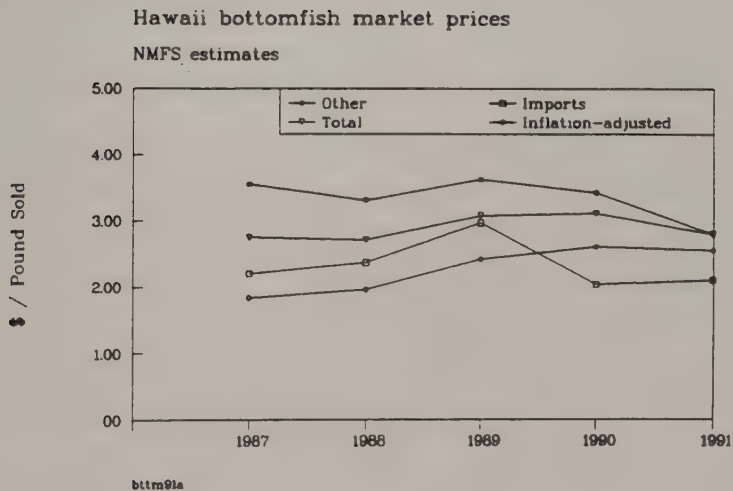
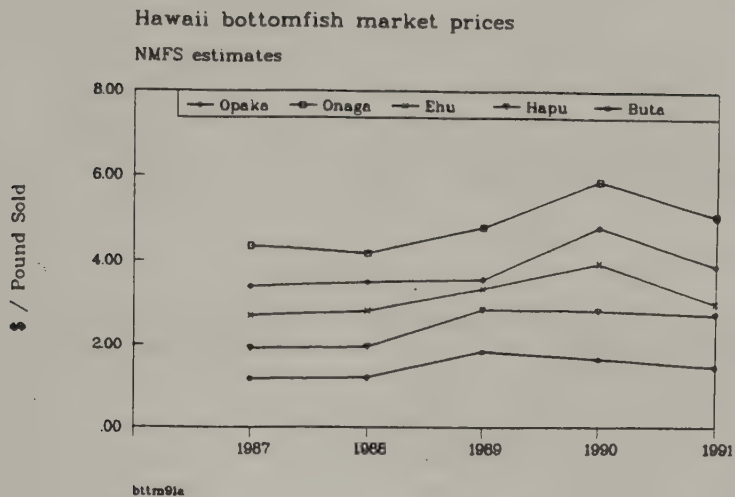


FIGURE H-13

DATA SOURCE:

Data from NMFS shoreside monitoring and U.S. FDA import samples.

CALCULATIONS & ADJUSTMENTS:

Prices compiled from a large sample of bottomfish sales at the wholesale purchase level in Honolulu.

INTERPRETATION:

Prices for most major species (opakapaka, onaga, and ehu) fell from 1990 to 1991, while other species prices have declined since 1989. The decline of opakapaka in the overall species composition means that aggregate prices have declined for two reasons: change in species composition and an overall decline in prices. Market sources indicate that the lower volume of bottomfish landings, combined with more available tunas and mahimahi, have depressed bottomfish market conditions. A re-evaluation of the supply and demand relationships in the bottomfish market is probably warranted.

CPUE FOR HAWAIIAN BOTTOMFISH

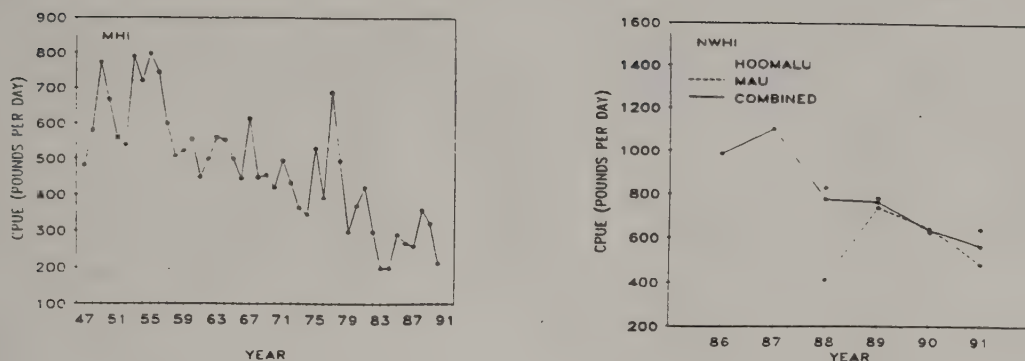


FIGURE H-14

DATA SOURCE:

Main Hawaiian Island (MHI) CPUE is based on data reported to HDAR by commercial fishermen. Northwestern Hawaiian Island (NWHI) CPUE is based on Honolulu auction data and vessel interview data collected by the NMFS market monitoring program.

CALCULATIONS & ADJUSTMENTS:

MHI and NWHI trips were screened to only include trips where at least 90% of the catch by weight was bottomfish. Additionally, MHI small boats were excluded by only including boats that had a maximum catch that year equal to or greater than 30% of the mean of the top ten maximum landings per boat. NWHI effort (fishing days per trip) was averaged and applied to all trips landing at least 1000 pounds of bottomfish. NWHI effort data prior to 1988 contained insufficient detail to allow separate Mau and Hoomalu CPUE calculations; therefore, the combined area NWHI CPUE is presented as well.

INTERPRETATION:

There is a long term decreasing trend in MHI CPUE, with current values less than half that of initial, signifying a yellow light condition. The increase in the late 1980's MHI CPUE was due primarily to a large increase in uku catches alone. NWHI CPUE continue to decrease in the Mau zone and increased slightly in the Hoomalu zones.

TABULATED VALUES:

YEAR	MHI CPUE (LBS PER DAY)	YEAR	NWHI CPUE (LBS PER DAY)		
			MAU	HOOMALU	COMBINED
1947	481	1986	NA	NA	988
1948	580	1987	NA	NA	1104
1949	773	1988	410	832	779
1950	667	1989	739	783	765
1951	559	1990	646	627	638
1952	539	1991	483	644	566
1953	789				
1954	719				
1955	798				
1956	744				
1957	599				
1958	506				
1959	521				
1960	555				
1961	448				
1962	499				
1963	560				
1964	552				
1965	499				
1966	443				
1967	612				
1968	446				
1969	453				
1970	419				
1971	495				
1972	433				
1973	363				
1974	344				
1975	530				
1976	390				
1977	688				
1978	494				
1979	296				
1980	368				
1981	418				
1982	296				
1983	198				
1984	198				
1985	290				
1986	266				
1987	258				
1988	357				
1989	320				
1990	211				

PERCENT IMMATURE IN HAWAIIAN BOTTOMFISH CATCH

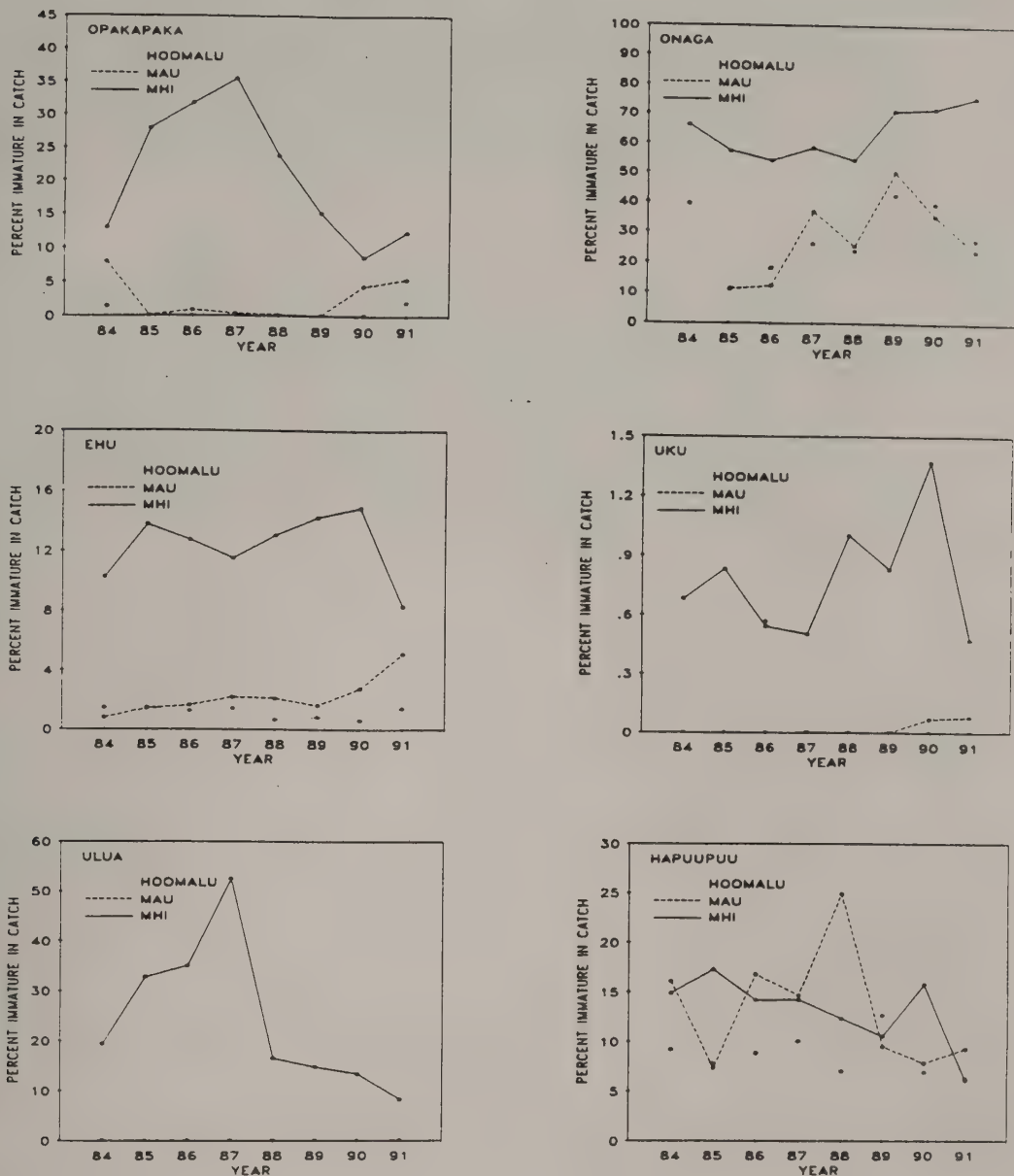


FIGURE H-15

DATA SOURCE:

Catch data obtained from Honolulu auction by NMFS personnel. Size at maturity from Everson (1984), Everson (1990 unpub. rep.), Everson et al. (1989), Kikkawa (1984), Sudekum et al. (1991).

CALCULATION AND ADJUSTMENTS:

Maturity was assumed to be "knife-edge", and all fish in the same lot were assumed to be of equal size. The percent immature is calculated in terms of weight. Values for ehu are different from previous year's reports because an updated weight at maturity is used (1.0 pounds instead of 1.6 pounds).

INTERPRETATION:

MHI catch is comprised of more immature fish than NWHI catch. MHI onaga catch has the highest percentage of immature fish, and is the only one consistently over fifty percent, signifying a yellow light condition. Percent immature for uku and hapuupuu are the lowest (i.e. healthiest) values. Among the other species, recent changes include decreases in NWHI onaga, MHI ehu and ulua; while opakapaka in all areas appears to be increasing in percent immature.

MEAN WEIGHT OF HAWAIIAN BOTTOMFISH

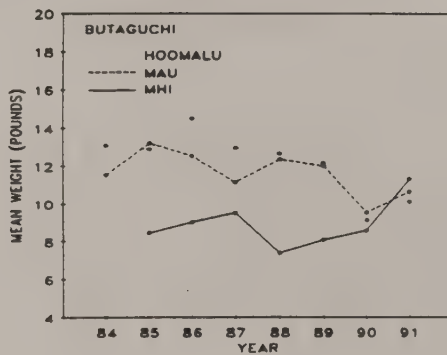
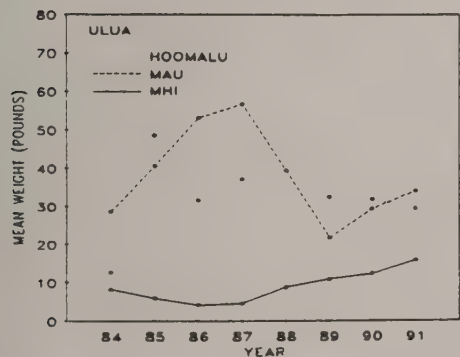
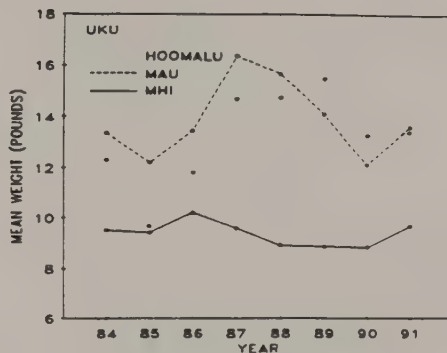
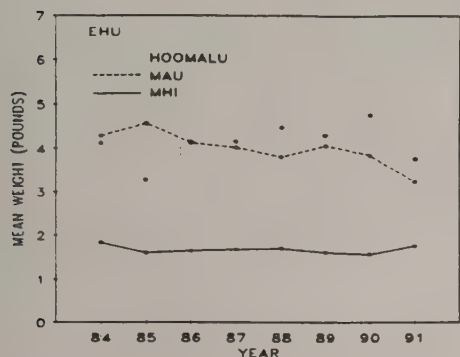
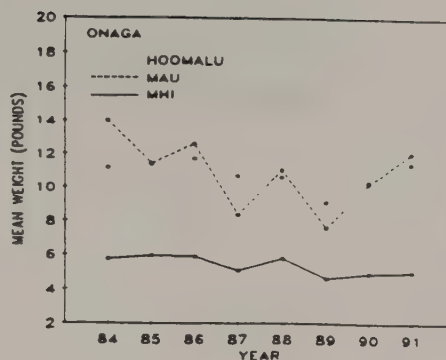
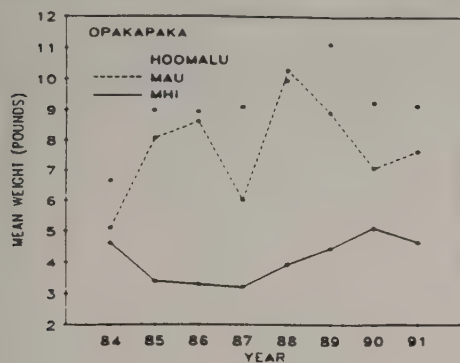


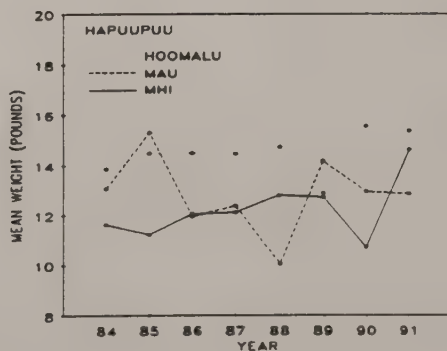
FIGURE H-16

DATA SOURCE:

Fish weight is obtained from catch data collected at the Honolulu auction by NMFS personnel.

INTERPRETATION:

Mean weights of fish in the NWHI catch are generally larger than those in the MHI catch. Mean weight of NWHI ehu has dropped in 1991.



In contrast to this, the mean weights of NWHI onaga, uku, and butaguchi have increased. The mean weights of NWHI opakapaka, ulua, and hapuupuu appear relatively stable. Except for opakapaka, the mean weights of most MHI species have increased.

SPAWNING POTENTIAL RATIO (SPR) FOR MHI BOTTOMFISH

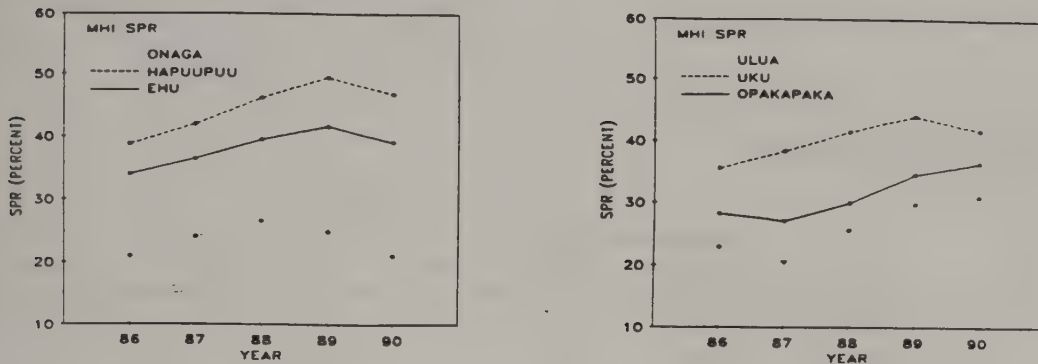


FIGURE H-17

DATA SOURCE:

SPR estimated from Honolulu auction size frequency data collected by NMFS personnel, and CPUE estimates from data reported to HDAR by commercial fishermen. Additional information for opakapaka obtained from size frequency data of fish caught from the R.V. Townsend Cromwell.

CALCULATION & ADJUSTMENTS:

Calculations use same methodology as presented in Somerton and Kobayashi (1990) for dynamic SPR. Virgin CPUE estimate is 1947-1951 mean; current CPUE estimate is a moving 3 year mean from 1984-1990. CPUE is of aggregate bottomfish. Virgin catch size composition is estimated from the earliest NWHI catch data. Ehu SPR is different from previous year's reports because a new weight at maturity was used (1.0 pounds instead of 1.6 pounds).

INTERPRETATION:

Current SPR estimates for all six species are above the twenty percent critical level used as an indicator of overfishing. Onaga, however, at twenty one percent, is nearly at the critical level of SPR. Hapuupuu and uku SPR values remain consistently the highest. The peak SPR values observed in 1989-1990 were largely a response to increases in aggregate CPUE due to increased uku landings.

TABULATED VALUES:

YEAR	SPR (%)					
	EHU	HAPU	ONAG	OPAK	UKU	ULUA
1986	34	39	21	28	36	23
1987	36	42	24	27	38	21
1988	40	46	27	30	42	26
1989	42	50	25	35	44	30
1990	39	47	21	37	42	31

SPAWNING POTENTIAL RATIO (SPR) FOR NWHI BOTTOMFISH

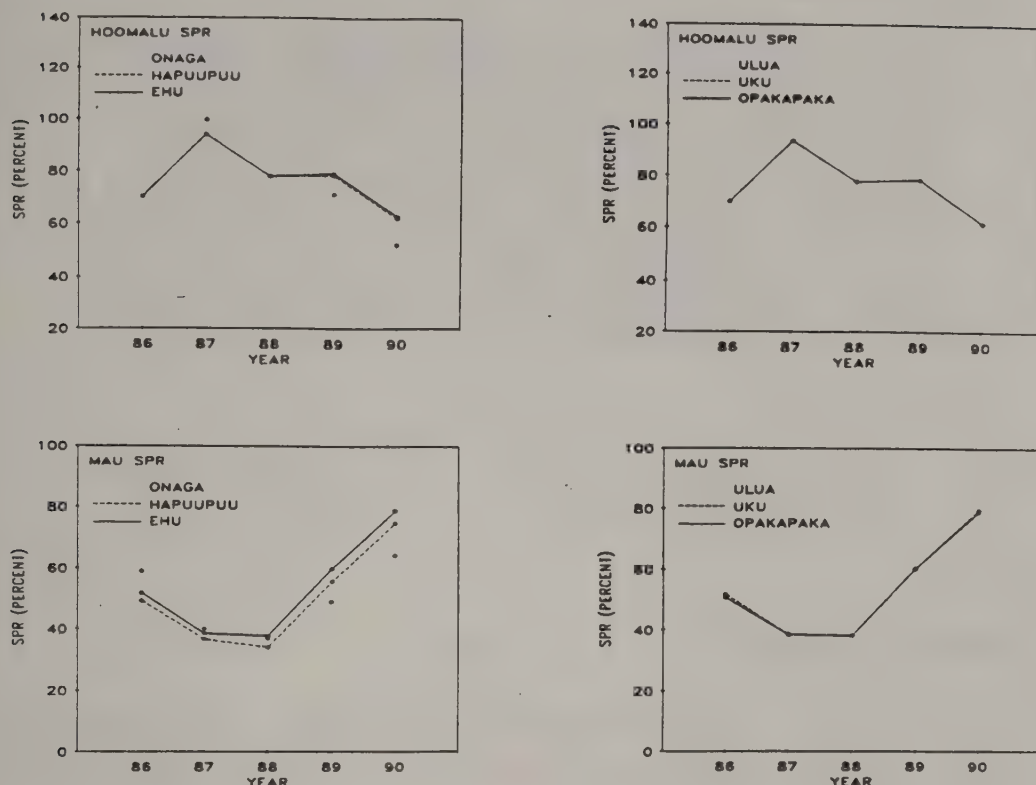


FIGURE H-18

DATA SOURCE:

SPR estimated from Honolulu auction size frequency data collected by NMFS personnel, and CPUE estimates from data reported to HDAR by commercial fishermen.

CALCULATION & ADJUSTMENTS:

Calculations use same methodology as presented in Somerton and Kobayashi (1990) for dynamic SPR. Virgin CPUE estimate is 1947-1951 mean; current CPUE estimate is a moving 3 year mean from 1984-1990. CPUE is of aggregate bottomfish calculated separately for Mau and Hoomalu zones. Virgin catch size composition is estimated from the earliest NWHI catch data.

INTERPRETATION:

Current SPR estimates for all six species are well above the twenty percent critical level used as an indicator of overfishing. The correlation of SPR values among species is due the high dependence of SPR on the CPUE component, given that the maturity component is nearly negligible. All species utilize the same aggregate bottomfish CPUE component. The maturity component is small relative to MHI SPR calculations because 1) the NWHI catch is primarily mature fish, and 2) the current catch size composition is relatively unchanged from the best estimate of the virgin catch size composition.

TABULATED VALUES:

YEAR	MAU SPR (%)					
	EHU	HAPU	ONAG	OPAK	UKU	ULUA
1986	52	49	59	51	52	52
1987	38	37	40	38	38	38
1988	38	34	37	38	38	38
1989	60	56	49	60	60	60
1990	79	75	65	79	80	80

YEAR	HOOMALU SPR (%)					
	EHU	HAPU	ONAG	OPAK	UKU	ULUA
1986	70	70	70	70	70	70
1987	94	94	99	94	94	94
1988	78	78	78	78	78	78
1989	79	78	71	79	79	79
1990	63	62	52	62	62	62

NORTHWESTERN HAWAIIAN ISLANDS BOTTOMFISH VESSEL ECONOMIC PERFORMANCE (INFLATION-ADJUSTED REVENUE PER TRIP), 1984-91.

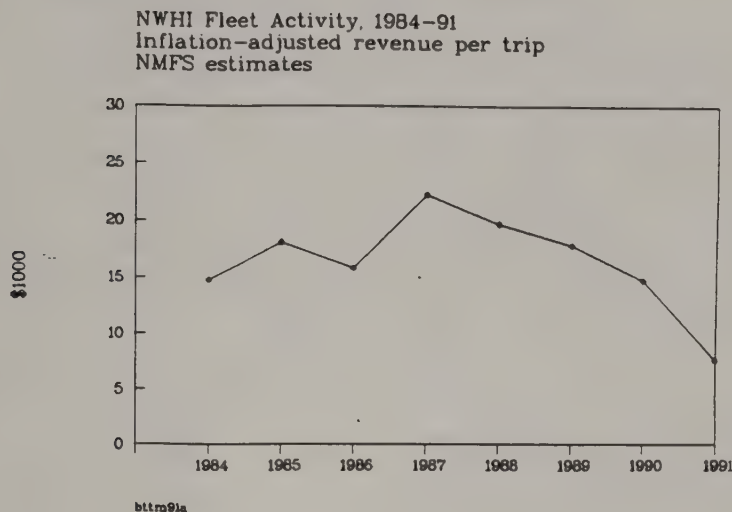


FIGURE H-19

DATA SOURCE:

Data from NMFS shoreside monitoring program.

CALCULATIONS & ADJUSTMENTS:

NMFS estimate of total revenue derived from the NWHI fishery, divided by the NMFS estimate of number of trips into the NWHI.

INTERPRETATION:

Although the data show a substantial decline in average revenue per trip, information on trip length (duration) suggests that recent years have shown a greater number of shorter trips, primarily by vessels operating out of Kauai. More detailed cost-earnings assessment is required.

ARMORHEAD STOCK ASSESSMENT

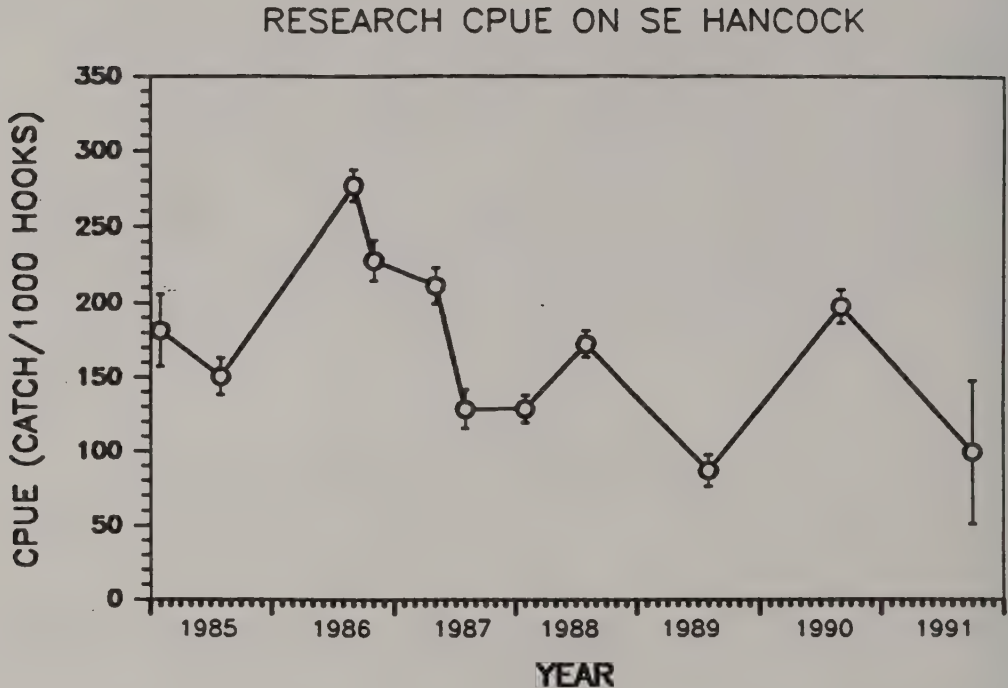


FIGURE H-20

DATA SOURCE:

Figure H-20 presents CPUE based on research longline catches at SE Hancock Seamount by NMFS, Honolulu personnel aboard NOAA ship R/V Townsend Cromwell. Vertical bars represent the 95% confidence intervals about the mean CPUE. The CPUE derived from the September 1991 stock assessment survey was computed using data from only the first 5 bottom longline sets as opposed to the standard 40 sets used on all other research surveys (see Appendix 1).

CALCULATIONS & ADJUSTMENTS:

Fishing gear and sampling methods utilized during armorhead stock assessment surveys at SE Hancock Seamount are described in Somerton (1988) and Somerton and Kikkawa (in prep.). The seamount is divided into quadrants and effort is portioned equally among quadrants. Within each quadrant, effort is conducted over four depth strata. CPUE is calculated as a depth stratified average. Based on gear

comparison studies of fishing droppers with and without hook timers conducted on the August 1990 survey, new coefficients accounting for the negative effects of hook timers were computed and applied to the catches obtained on all SE Hancock research surveys since 1985.

An analysis using the entire 1991 survey dataset revealed that the armorhead CPUE results were biased. The cause of this bias appears to be a reduction in gear performance caused by the activity of numerous large sharks (see Appendix 1). This situation began soon after the first day of fishing efforts and persisted throughout the remainder of the survey. As discussed in Appendix 1, the first 5 stations appear to have been little affected and on this basis, CPUE estimation procedure was adjusted by limiting the 1991 dataset to only these first 5 stations.

INTERPRETATION:

The decline in CPUE coupled with the absence of high "fatness index" armorhead in the catch indicates that no recruitment occurred in 1991. Therefore, the 1991 CPUE reflects the 1990 stock with an additional year of natural mortality. Since there is no fishing on SE Hancock Seamount and the 1991 decline in CPUE was not attributal to poaching (see Appendix 1), the fluctuations in CPUE shown in Figure H-20 are apparently the result of episodic recruitment followed by high natural mortality.

TABULATED VALUES:

MONTH/YEAR	ARMORHEAD CPUE
=====	
JAN 1985	181.28
JUN 1985	150.51
AUG 1986	276.80
OCT 1986	228.03
APR 1987	210.98
AUG 1987	128.73
JAN 1988	128.77
JUL 1988	172.14
JUL 1989	86.69
AUG 1990	197.08
SEP 1991	98.97

ARMORHEAD SPAWNING POTENTIAL RATIO

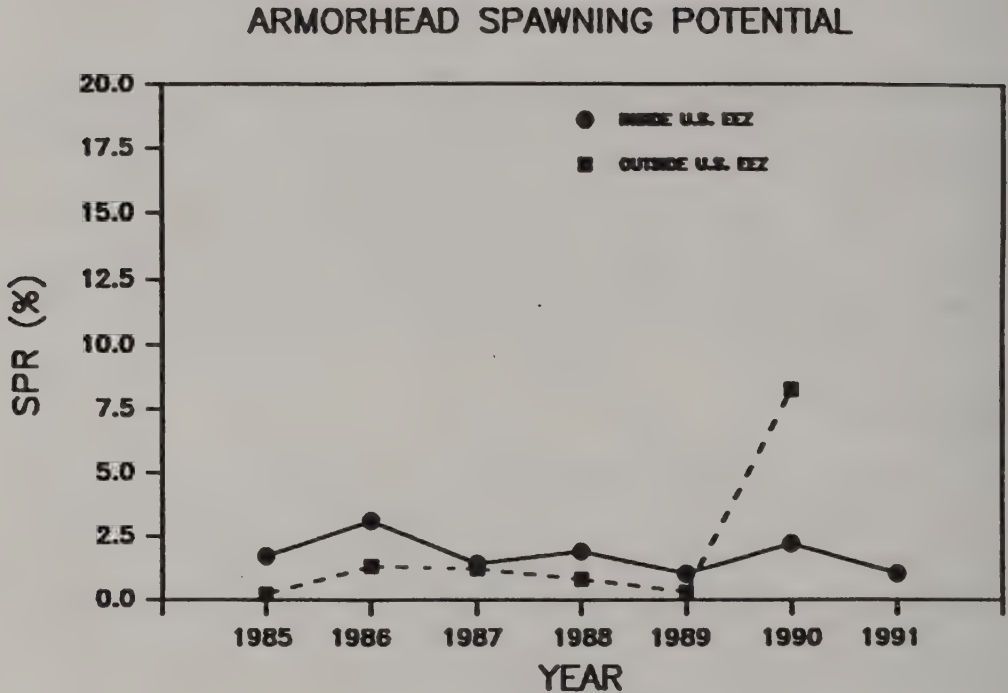


FIGURE H-21

DATA SOURCE:

SPR values for seamounts outside the U.S. EEZ are based on reported CPUE of Japanese trawlers and values for seamounts within the U.S. EEZ (Hancock Seamounts) are based on research longline CPUE in addition to the trawl CPUE.

CALCULATIONS & ADJUSTMENTS:

SPR values outside the U.S. EEZ are computed as the current year CPUE divided by the average CPUE during the first three years of the fishery (1970-1972). Since the previous report, additional catch and effort data outside the U.S. EEZ has become available from the Japanese trawl fishery for the years 1986-1988. This data has been incorporated with previous data by weighting the annual CPUE by effort from the two datasets. The revised and previous SPR values for outside the U.S. EEZ are 1.3% vs. 1.2% for 1986, 1.2% vs. 1.0% for 1987, and 0.8% vs. 0.4% for 1988, respectively.

SPR values inside the U.S. EEZ are computed as the estimated biomass on SE Hancock Seamount divided by the 1970-1972 average biomass. Biomasses are estimated using procedures described in Somerton and Kikkawa (in prep.). As reported above, the estimated armorhead biomass of SE Hancock Seamount for 1991 is based on only the first 5 stations and otherwise follows the estimation procedures of Somerton and Kikkawa (in prep.).

INTERPRETATION:

SPR within the region outside of the U.S. EEZ, which represents approximately 99% of the known armorhead habitat, is currently (1990) about 8.2%. This apparently represents the first substantial increase in armorhead stocks outside the U.S. EEZ since 1978. The current estimate of SPR inside the U.S. EEZ (SE Hancock Seamount) is 1.0%. These SPR values are still well below the threshold value of 20% needed to initiate fishing within the EEZ. In each region, particularly inside the U.S. EEZ, armorhead remains depleted and no fishing should be allowed. Since the 1985 inception of the fishing moratorium on the Hancock Seamounts, the SPR inside the U.S. EEZ has remained consistently low with no sign of recovery. Recovery of the armorhead population at SE Hancock Seamount from past over-exploitation has been further hindered by the complete absence of fishery management on the southern Emperor-northern Hawaiian Ridge seamounts outside the U.S. EEZ. Furthermore, recent population genetic data indicates little if any genetic differentiation among armorhead at different seamounts (Martin et al., in press). This apparently indicates that armorhead do not necessarily return to their natal seamount upon completion of the pelagic phase. Hence, any recovery of the population at SE Hancock Seamount may not insure succeeding population levels are similarly sustained without concurrent increases in the seamount populations outside the U.S. EEZ. Despite the apparent increase in armorhead outside the U.S. EEZ, armorhead population levels both inside and outside the U.S. EEZ still remain low. We therefore recommend that the current moratorium on fishing at the Hancock Seamounts remain in effect beyond the 1992 expiration date.

TABULATED VALUES:

YEAR	ARMORHEAD SPR (%)	
	INSIDE US EEZ	OUTSIDE US EEZ
1985	1.7	0.2
1986	3.1	1.3
1987	1.4	1.2
1988	1.9	0.8
1989	1.0	0.3
1990	2.2	8.2
1991	1.0	NA

Northern Mariana Islands 1991 Descriptors and Indicators

	<u>Page</u>
Introduction	101
 Descriptors	
 <u>Landings Information</u>	
Aggregate Catch	104
1991 Commercial Landings by Species	105
 <u>Effort Information</u>	
Number of Trips	106
 <u>Participation Information</u>	
Number of Boats	107
 <u>Economic Information</u>	
Aggregate Revenue	104
1991 Average Price by Species	105
Aggregate Average Price	108
 Indicators	
Revenue Per Trip	109
Catch Per Trip	111
 Recommendations	 112

Introduction

The CNMI bottomfish fishery occurs primarily surrounding the islands of Saipan, Tinian, Rota, Farallon de Mendilla, Anatahan and Aguigan. However, this discussion will be limited to the catches landed in Saipan which is by far the largest market. The fishery will be characterized by data collected through the Commercial Purchase Data Base which indirectly records actual landings by recording all local fish sales to commercial establishments. This data collection system is dependent upon first-level purchasers of local fresh fish to accurately record all fish purchases by species categories on specially designed invoices. Division of Fish and Wildlife (DFW) staff routinely collects and distributes invoice books to more than 50 participating local fish purchasers; which includes practically all fish markets, stores, restaurants, hotels and roadside vendors ("fish mobiles"). Although this data collection system has been in operation since the mid-1970's, only data collected since 1983 are considered accurate enough to be comparable for most aspects of the fisheries.

Although this data base lacks information concerning fishing methodology, location and fishing effort, the Offshore Port Sampling Survey provides the additional data required for further analysis. The Offshore Port Sampling Program has recently been improved through the hiring of two additional personnel, data sheet modification and an increase in effort with respect to field sampling. The NMFS Honolulu Lab personnel are presently finalizing the computer software programs necessary to calculate an estimate of total landings and effort by method. Historical port sampling data is presently being entered into the computer.

The CNMI's bottomfish fishery consists primarily of small scale local boats engaged in commercial and subsistence fishing. Deepwater (500-700 feet) fishing, targeting onaga and other prized snappers, is largely commercial, whereas, those targeting shallow water (100-500 feet depths) species, such as the emperors, can also be subsistence. It is assumed that hand lines, home fabricated hand reels or electric reels are the only gear utilized for the bottomfish fishery. Historically, some fishermen's trips frequently lasted more than one day, currently however, effort is defined and calculated on a daily trip basis. Fishing trips are generally restricted to the daylight hours with all vessels returning before or soon after sunset.

The bottomfish fleet consists primarily of vessels less than 24 feet in length and are usually limited to a 20-mile radius from Saipan. The larger vessels are able to fish extended trips, sometimes traveling as far as Pagan.

Bottomfishing commands more skill than pelagic trolling and requires knowledge on the location of specific submerged bottom features and hooking techniques. Presently, bottomfishing can be

described as "hit or miss". Without fathometers and even nautical charts the majority of fisherman fish randomly, many times relying on land features for guidance to a fishing area. This type of fishing is very time inefficient and usually results in a low CPUE when compared with pelagic trolling. Of the approximate 19 bottomfishermen, it is our understanding that only two fisherman are presently using fathometers for fishing activities.

Although the data shows a declining fishery there are indications of new interest in bottomfishing. During 1989 and 1990 training exercises for bottom longline fishing was jointly sponsored by the South Pacific Commission and the CNMI Division of Fish and Wildlife (DFW). Participation from local fisherman was overwhelming, with approximately 50 individuals participating, and the original training period was extended. Although the bottom longline was found to be impractical in Saipan bottom fishing grounds, the participants were introduced to the proper use of fathometers, nautical charts and boat anchoring techniques; tools which were not currently used by the fisherman. An influx of new fishermen were expected in 1991, however, the increase never materialized.

It is most likely that the decline of the bottomfish fishery may be related to any one or a combination of reasons attributable to cultural and/or career changes of the highliners. Some of the possible causes are discussed as follows:

- 1) The Saipan bottomfish fishery has become a semi-closed and erratic fishery with very few, if any, fisherman regularly fishing for bottom fish. The majority of fishermen are part-time, and their role in the fishery, and the fishery itself, is declining. Highliners, of which there are a few, account for most of the landings reported. In the past, experienced bottom fishermen tended to share information, however, this situation no longer exists and the experienced bottom fishermen are not relaying information to others. This break in information transfer may be culturally based or related to the lack of bottomfish resources surrounding Saipan. In any event, this is prohibiting many potential new bottom fisherman from starting in the fishery.

- 2) The primary reason to bottomfish is when the pelagic market is saturated. As Saipan's population increased the market demand for pelagic fish increased and since Saipan's pelagic landings did not increase as much as the market demand, fewer "opportunities" were presented to bottom fish. When faced with a choice, pelagic fishing becomes the most favored option

- 3) Since 1989 several of the most active commercial bottom fishermen have decreased fishing activity or have ceased fishing altogether. Several specific examples follow:

- a) Fisherman Number 1: The largest supplier of bottomfish until his 68-foot fishing vessel was lost to fire. To date, he has not re-entered the fishery.

b) Fisherman Number 2: One of the most active commercial bottom fisherman who changed careers and has stopped bottom fishing on a regular basis.

c) Fisherman Number 3: Historically, the most active bottomfishing fleet in the northern islands with four vessels operating: **Ordin I**, **Ordin II**, **Ordin III** and the **St. Christopher**. Currently, bottom fishing activities have decreased by approximately 90%.

d) Fisherman Number 4: Although not substantially related to the latter portion of the 1991 bottomfish data base, this active bottom fisherman was recently elected to a political office and has substantially decreased his presence in the market.

4) Many of the larger vessels which historically fished bottomfish are no longer in operation or have discontinued bottomfishing activities. Only one large vessel (greater than 30 feet in length) entered the bottomfish market during 1991 and that was done on only two occasions.

CNMI Commercial Bottomfish Landings and Revenue

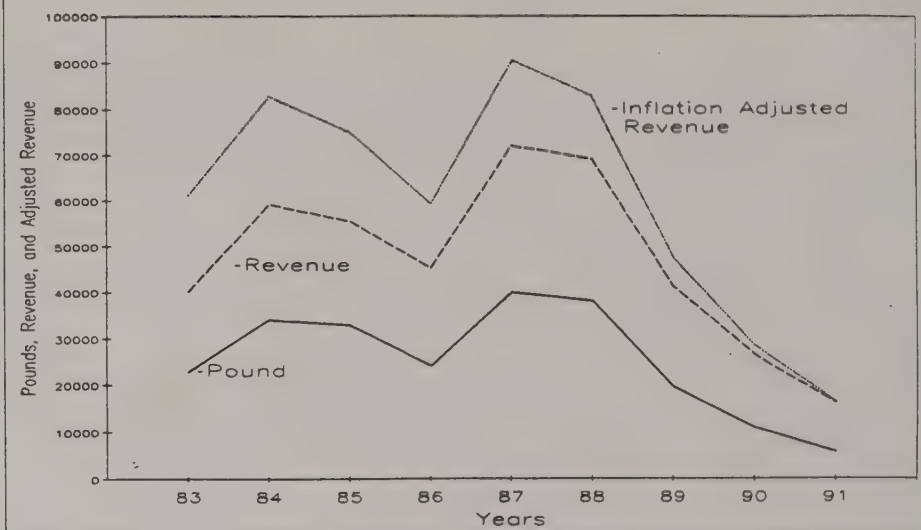


Figure 1. CNMI commercial bottomfish landings and revenue.

Summary of annual data

<u>Year</u>	<u>Pounds</u>	<u>Revenue</u>	<u>Adjusted revenue</u>
1983	22,683	40,003	61,044
1984	33,924	59,005	82,783
1985	32,780	55,396	74,784
1986	23,929	45,079	59,278
1987	39,772	71,868	90,553
1988	37,850	69,052	82,655
1989	19,550	41,379	46,758
1990	10,903	26,323	28,402
1991	5,688	16,108	16,108

Calculation: Landings in pounds are from a simple data base summation of reported purchases of all bottomfish species combined. Revenue in dollars is from the same type of data base summation of the value field. The inflation adjustment is made using the Consumer Price Index (CPI) and establishing the 1991 CPI figure as the basis by which calculations of previous years' prices are made. Since the CNMI CPI was not available for the years 1983 - 1987, Guam's CPI was used as a basis for back calculating the missing CNMI values.

Interpretation: Landings, revenues and adjusted revenues continued the steady decline which began in 1989. Although data collection effort was lacking in the 1991 data base, this would only explain a small portion of the decline. The overall decline appears correlated with the amount of effort in the fishery (Figure 2 and 3). In contrast, many fisherman believe there is a lack of good bottomfishing areas surrounding Saipan.

Table 1. CNMI 1991 commercial landings of bottomfish species.

Species	Pounds	Revenue	\$/LB
Bottomfish*	3,437	9,082	2.64
Groupers	504	1,462	2.90
Onaga	140	682	4.87
Opakapaka	503	1,765	3.51
Emperor	964	2,831	2.94
Bottomfish totals:	5,688	16,108	2.83

* - denotes miscellaneous or non-identified species

Calculation: Annual summaries for each species from invoice data sheets.

Note: Landing estimates from the 1991 Commercial Purchase Data Base was under estimated and is presently being re-evaluated in an attempt to generate a better estimate of total landings. During 1991, the number of vendors increased dramatically but the collection effort remained the same. There are presently more than 50 participating local fish purchasers compared to the approximate 20 that were collected during 1991. Even with low data collection effort in 1991, those 20 vendors purchased most of the fish on Saipan.

Interpretation: Unfortunately, 60% of all 1991 bottomfish landings were not identified by species groups and any interpretations based on the above data would be highly questionable.

The deep water bottomfish, Onaga and Opakapaka, commanded the higher prices per pound, while prices for the shallower water bottom fish, groupers and emperor, ranged from 0.57 to 1.97 per pound less.

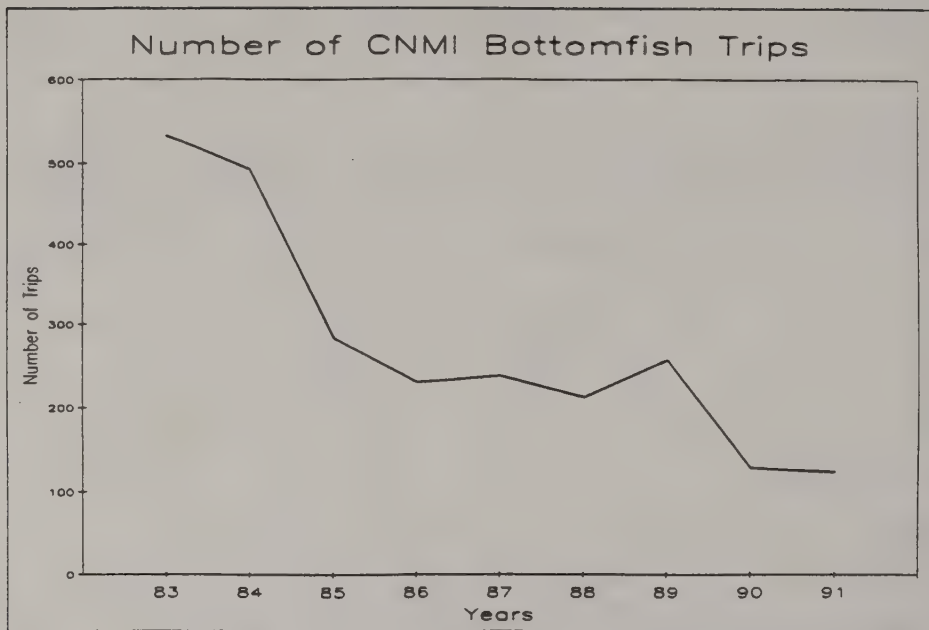


Figure 2. Number of CNMI bottomfish trips.

Summary of annual data

<u>Year</u>	<u>Trips</u>
1983	533
1984	492
1985	283
1986	229
1987	237
1988	211
1989	257
1990	129
1991	123

Calculation: The number of trips which resulted in landing any amount of any bottomfish species are tallied by adding each recorded fisherman's trip on a given day. The assumptions are that each fisherman lands only once in a given day, and that he sells all of his catch on that day. Most trips are a single day length, but it is known that some longer trips do occur.

Interpretation: An obvious decrease has occurred in the number of bottomfishing trips being taken by the CNMI fleet as most effort is assumed to be directed towards pelagic trolling. In addition, many of the newer fisherman are re-directing effort toward the tourist industry, where greater revenues may be possible with relatively fewer problems. An indication of this may be related to the increase in U.S. Coast Guard licenses issued in Saipan during the last couple years. A U.S. Coast Guard license is required for any vessel operator that carries passengers for hire; ie., tourist transportation.

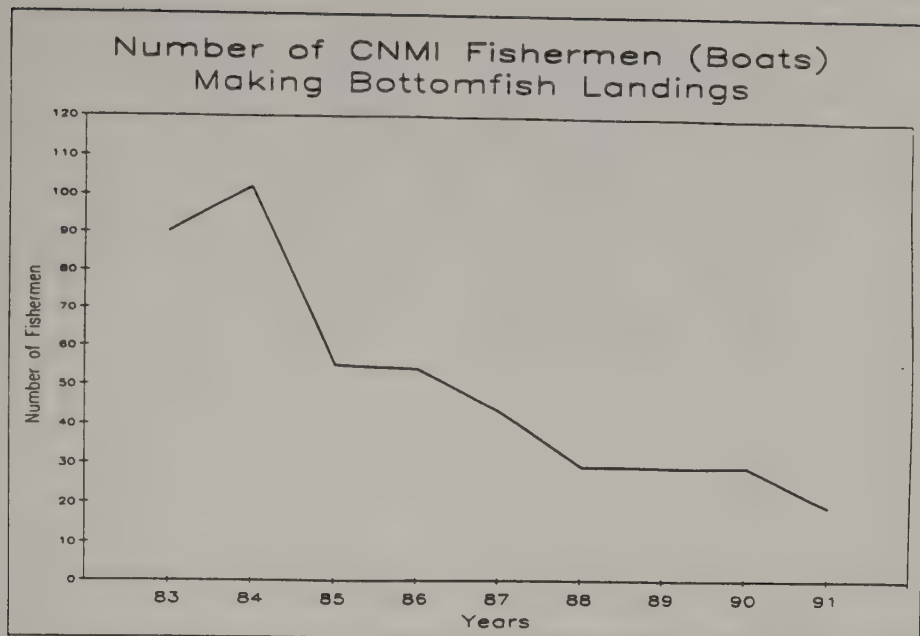


Figure 3. Number of CNMI fishermen (boats) making bottomfish landings.

Summary of annual data

<u>Year</u>	<u>Number of boats</u>
1983	90
1984	102
1985	55
1986	54
1987	43
1988	29
1989	29
1990	29
1991	19

Calculation: The fisherman or boat selling the catch is identified on the "trip ticket" invoices used by purchasers. The plot shows the number of unique fishermen making any landings of bottomfish within a given year.

Interpretation: As with the number of trips (Figure 3), the number of boats or fishermen making commercial landings of any bottomfish species has declined continuously since 1984 but appears to have stabilized between 1988-90, before decreasing again in 1991.

Overall, the motivation to bottom fish is declining and only highliners are significantly active as discussed in the 1990 Bottomfish Report. A discussion of possible causes of this observed decline was presented in the Introduction Section.

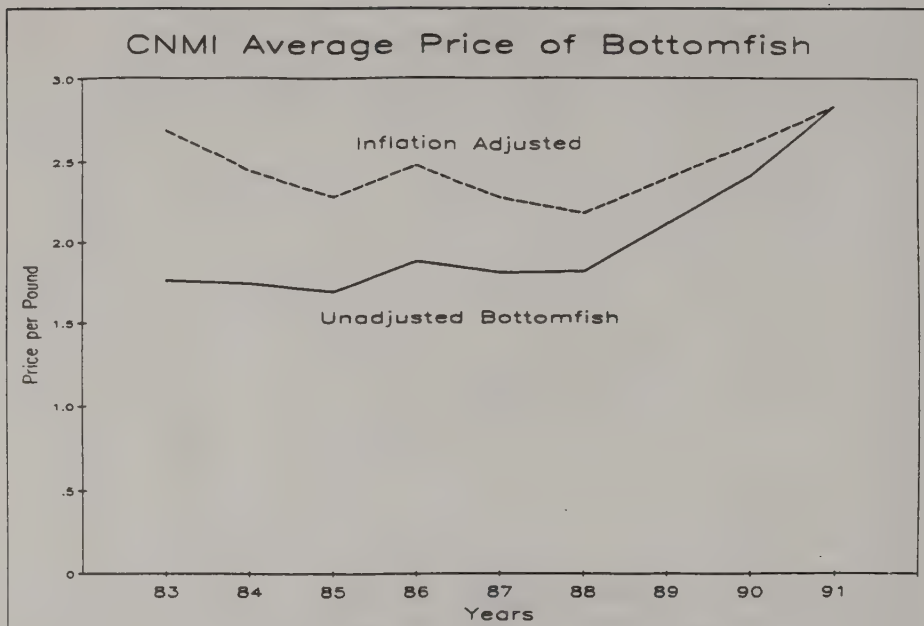


Figure 4. CNMI average price of bottomfish.

Summary of annual data

<u>Year</u>	<u>Unadjusted \$/LB</u>	<u>Adjusted \$/LB</u>
1983	1.76	2.69
1984	1.74	2.44
1985	1.69	2.28
1986	1.88	2.47
1987	1.81	2.28
1988	1.82	2.18
1989	2.12	2.40
1990	2.41	2.60
1991	2.83	2.83

Calculation: The average price of the bottomfish complex is calculated by dividing the total revenue by the total landings. The inflation adjustment is made using the Consumer Price Index (CPI) and establishing the 1991 CPI figure as the basis by which calculations of previous years' prices are made. Since the CNMI CPI was not available for the years 1983 - 1987, Guam's CPI was used as a basis for back calculating the missing CNMI values.

Interpretation: The average price per pound has been increasing since 1988 and reached a record of \$ 2.83 in 1991. This increase in price is most probably related to the decrease in bottomfish landings and resulting market demand remaining constant or increasing.

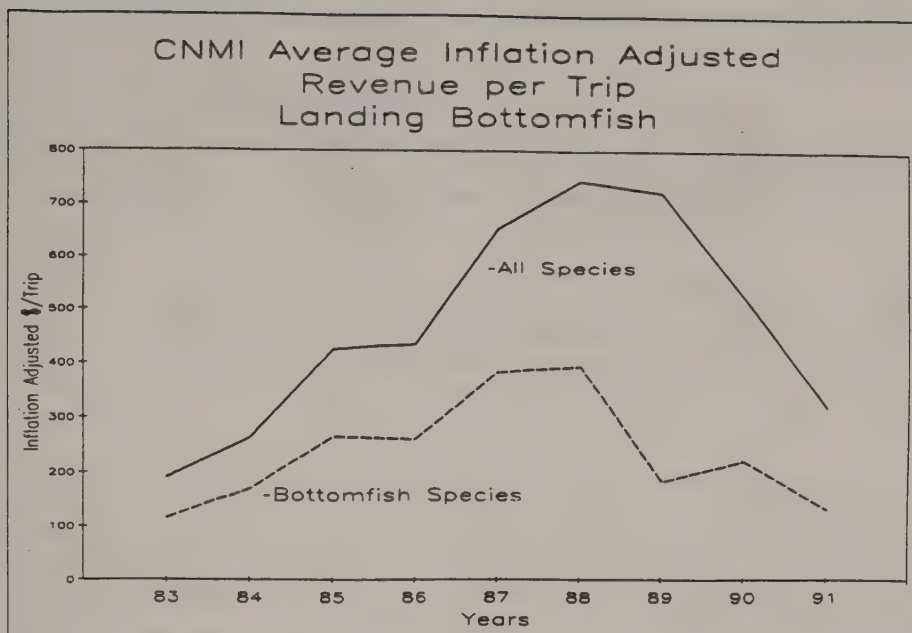


Figure 5. CNMI average inflation adjusted revenue per trip landing bottomfish.

Summary of annual data

<u>Year</u>	<u>Bottomfish species</u>	<u>All species</u>
1983	115	189
1984	168	262
1985	264	423
1986	259	434
1987	382	652
1988	392	743
1989	182	722
1990	220	523
1991	131	318

Calculation: Only trips which landed any bottomfish species are included in these calculations. The "Bottomfish \$/Trip" is the total revenue of the bottomfish species sold from a trip, and the "All Species \$/Trip" is the total trip revenue of all species combined (e.g. any pelagic and reef fish which were sold).

The inflation adjustment is made using the Consumer Price Index (CPI) and establishing the 1991 CPI figure as the basis by which calculations of previous years' prices are made. Since the CNMI CPI was not available for the years 1983 - 1987, Guam's CPI was used as a basis for back calculating the missing CNMI values.

Interpretation: In general, inflation adjusted bottomfish revenues continue to decrease in 1991 after experiencing sharp initial declines in 1988-89. The decline of the all species inflation adjusted revenues has declined drastically since 1989, more so than the inflation adjusted bottomfish revenues.

The actual difference in price between inflation-adjusted bottomfish revenue and inflation-adjusted all species revenue decreased in 1991 when compared to the obvious disparity during 1987 to 1989. Fewer bottomfish entering the market may have been responsible for increased revenues (higher price per pound generated by the scarcity of valued species).

Overall, bottomfishes comprised an ever decreasing portion of the total landings from fishing trips until 1990 when that difference had lessened. The bottomfish fishery has always been a small proportion of the total fisheries. However, it appears that bottomfish is comprising a relative higher percentage of the trip revenue in which bottom fish were caught.

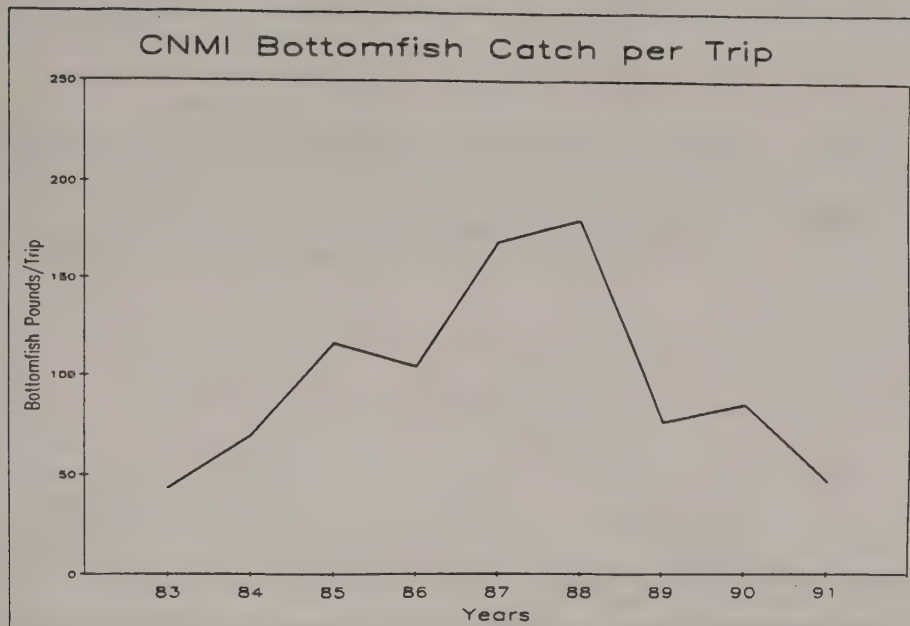


Figure 6. CNMI bottomfish catch in average pounds per trip.

Summary of data

<u>Year</u>	<u>Pounds per trip</u>
1983	43
1984	69
1985	116
1986	104
1987	168
1988	179
1989	76
1990	85
1991	46

Calculation: The average catch per trip is calculated by dividing the total weight of all bottomfish landings by the number of trips which landed bottomfish, regardless of the amount of bottomfish landed on any given trip. Although the average catch per trip is not a very good measure of CPUE, because it is subject to significant biases (e.g. changes in trip length and relative amounts of bottomfishing compared to trolling), it is the only measure readily possible from the commercial landings system. It may be possible to improve this measure of CPUE by using only those trips which landed bottomfish species exclusively, but that has not been done yet. It is believed that the sample size resulting from this exercise would be extremely small and subject to other biases, however, it should be investigated in the future.

Interpretation: Even though bottomfish effort and landings are decreasing, it appears that the revenue obtained from bottomfish sales are becoming relatively more important. This may be a function of the bottomfish fisherman trolling to and from the bottom fishing site, thus having a mixed catch after spending the "day" bottomfishing.

Recommendations

Bottomfishing in the CNMI is declining as local fishermen focus their efforts on pelagic trolling, tourist related interests or discontinue bottomfishing all together. This decline is expected to be short lived evidenced by the overwhelming interest in the SPC/DFW bottom longline training project. Domestic U.S., joint-venture, and foreign vessels continue to inquire about full-time bottomfishing throughout much of the CNMI. A local fishing company is presently offering bottom fishing trips, however, the impact to the commercial market is presently unknown. During the 1992 year, charter boat activities and their impact on the local fisheries market will be investigated. A system of collecting biological data for the charter boat catches will be attempted.

Revenues and prices will most likely increase with renewed fishing interest and the market appears to be ever growing. Deepwater snappers almost always command good prices. Fishermen utilizing larger vessels will have greater access to these fishes; the market for them will improve as well, providing that better preservation techniques are utilized. Presently, only a few fishermen invest effort in properly chilling their catch. A DFW representative has recently completed a training course involving fish handling and processing methodology. It is expected that the information gleaned from this course will be passed on to the local fisherman possibly during an future workshop pertaining to bottom fishing.

The local fisherman are in serious need of continuing education related to the bottom fishing methodologies introduced during the jointly sponsored SPC/DFW bottom longline training project. Specifically, this workshop should address the proper operation and interpretation in the use of fathometers and nautical charts. In addition, electric reel repair, anchoring techniques, marketing and handling could also be addressed.

With the planned expansion of biological data collection from the bottomfish fishery, an outline can be developed for the bottom fish stocks surrounding Saipan. After identifying the extent of resource utilization additional data collecting could be used for determining management strategies.

APPENDIX 1.--ARMORHEAD STOCK ASSESSMENT FOR 1991

Problem

The September 1991 armorhead stock assessment survey to SE Hancock produced the lowest research CPUE (21.32 armorhead per 1,000 hooks fished; based on all 39 stations conducted) since the inception of these research surveys in January 1985. The respective armorhead biomass estimate was 4.45 mt; an order of magnitude decrease from the August 1990 biomass estimate of 47.58 mt. Another unusual feature of the 1991 survey was the persistent presence of large sharks, presumably Carcharhinus galapagensis, around the research vessel while at SE Hancock. Three possible explanations for the dramatically low values for the 1991 research CPUE and biomass estimates include: 1) biased survey results due to the activity of large sharks during the 1991 survey; 2) poaching; and 3) a sharp increase in natural mortality during the 1990-1991 period between surveys.

Analysis

To help evaluate these three possible explanations, the pattern of CPUE over consecutive bottom longline stations was examined for each of the 5 digital hook timer surveys conducted to-date (August 1987, July 1988, July 1989, August 1990, and September 1991). A linear regression of CPUE on consecutive station for each survey (Figures 1a-1e) reveals that only for the

1991 survey does the regression line have both a negative slope and a highly significant deviation ($P < 0.05$) from a slope of zero (Table 1). Furthermore, unlike any of the previous digital hook timer surveys, the 1991 survey yielded no catches of armorhead during virtually the entire second half of the survey (Figure 1e).

An alternate approach at estimating the 1991 biomass and CPUE was conducted by limiting the data examined for 1991 and other digital hook timer surveys to only the first 5 stations of each survey but otherwise following the same estimation procedures described in Somerton and Kikkawa (in prep.). The rationale for using such a restricted portion of the total dataset was the likely fishing interference due to the persistent occurrence of numerous large sharks throughout most of the 1991 except for the initial first few stations. If shark activity did alter the catchability of the bottom longline gear during the 1991 survey, then only the first few sets (before the sharks behaviorally adapted to the routine of the fishing operations) may yield CPUEs representative of the actual relative abundance of armorhead. Linear regression of CPUE from the first 5 stations on consecutive station yielded slopes not significantly different (at $P = 0.05$ level) from zero (Table 1) for 1991 and all other digital hook timer surveys and allowed for a comparison of CPUE and biomass estimates based on the first 5 stations and all stations for each of the digital hook timer surveys.

Another approach to estimating biomass (but not CPUE) relies on the instantaneous natural mortality (M) value (0.045/month) and evidence from the fatness index distributions that recent recruitment bolstered the population abundance in August 1986, July 1988, and August 1990 (Somerton and Kikkawa, in prep.). Since no recruitment was evident during the intervening digital hook timer surveys (August 1987 and July 1989) and in 1991, alternate biomass estimates could be calculated as follows:

$$\text{BIOMASS}_t = (\text{BIOMASS}_{t=0}) * (e^{-(M * \text{TIME IN MONTHS})})$$

Results of CPUE and biomass estimates appear in Tables 2 and 3, respectively.

INTERPRETATION:

With the initial results of the 1991 survey based on all 39 stations (CPUE= 21.321 armorhead/1,000 hooks and biomass= 4.45 mt), the assumption of no fishing at SE Hancock during 1990-1991 was re-examined as well as other possible causative factors. The pattern of declining CPUE over consecutive stations for the 1991 survey (Figure 1e) was distinctly different from all other previous surveys using digital hook timers (Figures 1a-d). This pattern of declining CPUE resembles that of a depletion experiment where a closed population is diminished by heavy fishing over a short period of time. However, only 123 armorhead

were captured during the entire 1991 survey. For a population to have been depleted by such a small catch, one would expect a much lower average CPUE for the first four stations than that encountered during the 1991 survey. Furthermore, if one compares the 1991 biomass estimate (4.45 mt) based on the entire 1991 data set with that of the 1990 estimate (47.58 mt), the instantaneous natural mortality rate (M) of 0.045/month derived by Somerton and Kikkawa (in prep.) would need to have been quadrupled during the intervening 1990-1991 survey period to account for such a decline in abundance. It would seem that the most plausible explanation consistent with the available data is that shark activity, beginning early in the survey, substantially decreased the catchability of the gear for the remainder of the cruise. One measure of shark interference is the loss rate of digital hook timers. These timers are secured such that loss by bottom fouling is unlikely since the hook, and not the timer, is the weak link in the gangion. Timer loss rate was highest for the 1989 and 1991 surveys (Figure 2) which coincided with those cruises plagued with the high presence of large sharks. Despite the presence of sharks, the pattern of CPUE over time for the 1989 survey (Figure 1c) was dissimilar to that encountered in 1991 (Figure 1e). It would appear that during the 1991 survey, shark presence and activity may have been so pervasive that armorhead avoided the gear and/or were kept "at bay" during the gear's bottom soak time. Attempts at night bottom fishing on the summit and upper slopes using hydraulic gurdies confirmed that

large sharks were capable of being present at or near bottom. Given the available evidence, it would appear that the 1991 CPUE and biomass estimates based on the entire survey dataset yielded anomalous values due to the interference of shark activity on gear performance. The occurrence of poaching or a sharp increase in natural mortality are considered less plausible since these factors would be expected to produce an overall low CPUE for the survey with a slope not significantly different (at the 0.05 level) from zero.

CPUE and biomass estimates derived from an abbreviated dataset consisting of only the first 5 stations and biomass estimates derived from applying the natural mortality rate yield similar estimates to those derived from the entire survey dataset except for the 1990 and 1991 surveys (see Tables 2 and 3). Estimated differences for 1990 are probably due to the overall rise in CPUE particularly with respect to the early and latter portion of the 1990 survey (Figure 1d). The general agreement between the CPUE and biomass estimates based on the abbreviated (first 5 stations) and entire dataset (with both estimation procedures following the methods of Somerton and Kikkawa (in prep.)) for surveys prior to 1990 and the close agreement in non-recruitment year (1987, 1989, and 1991) biomass estimates between the abbreviated and natural mortality method appears to indicate that the abbreviated method can usually yield an average CPUE and biomass estimate in general agreement with estimates based on the entire survey dataset. Based on the abbreviated dataset, the

1991 armorhead CPUE and biomass estimates are 98.97 per 1,000 hooks and 21.49 mt, respectively. However, the 1991 estimate of CPUE have a much greater 95% confidence interval than if based on the entire 1991 dataset (Table 2).

TABLE 1.--Probability (P) for each digital hook timer survey that linear regression of CPUE on consecutive station produces a slope whose deviation from zero is due to chance alone. Probabilities based on calculations using all stations and first 5 stations of each survey. All CPUE calculations follow procedures set forth in Somerton and Kikkawa (in prep.).

SURVEY	ALL STATIONS	FIRST 5 STATIONS
AUG 1987	P= 0.687	P= 0.264
JUL 1988	P= 0.750	P= 0.275
JUL 1989	P= 0.302	P= 0.384
AUG 1990	P= 0.093	P= 0.834
SEP 1991	P=<0.001	P= 0.572

TABLE 2.--Comparison of CPUE estimates from digital hook timer surveys based on an abbreviated dataset (first 5 stations) and the entire survey dataset. Both approaches follow the calculation procedures of Somerton and Kikkawa (in prep.). CPUE in units of armorhead per 1000 hooks fished.

MEAN CPUE (AND 95% CONFIDENCE INTERVAL)

SURVEY	Abbreviated Dataset	Entire Dataset
AUG 1987	159.28 (132.65-185.92)	128.73 (115.46-142.00)
JUL 1988	174.82 (145.15-204.50)	172.14 (163.28-181.00)
JUL 1989	78.59 (54.63-102.56)	86.69 (76.12-97.25)
AUG 1990	113.01 (86.75-139.27)	197.08 (185.94-208.23)
SEP 1991	98.97 (50.79-147.15)	21.32 (17.15-25.49)

TABLE 3.--Comparison of biomass estimates of digital hook timer surveys based on natural mortality, an abbreviated dataset (first 5 stations) and the entire dataset. Estimates based on the abbreviated and entire dataset follow the procedures of Somerton and Kikkawa (in prep.). Average biomass estimates of armorhead use mean CPUE and are in metric tons (mt).

BIOMASSS ESTIMATES BASED ON:			
SURVEY	Entire Dataset	Abbreviated Dataset	Natural Mortality
AUG 1987	34.68	45.06	43.15
JUL 1988	41.72	40.05	--
JUL 1989	19.07	19.46	24.31
AUG 1990	47.58	26.80	--
SEP 1991	4.45	21.49	26.51

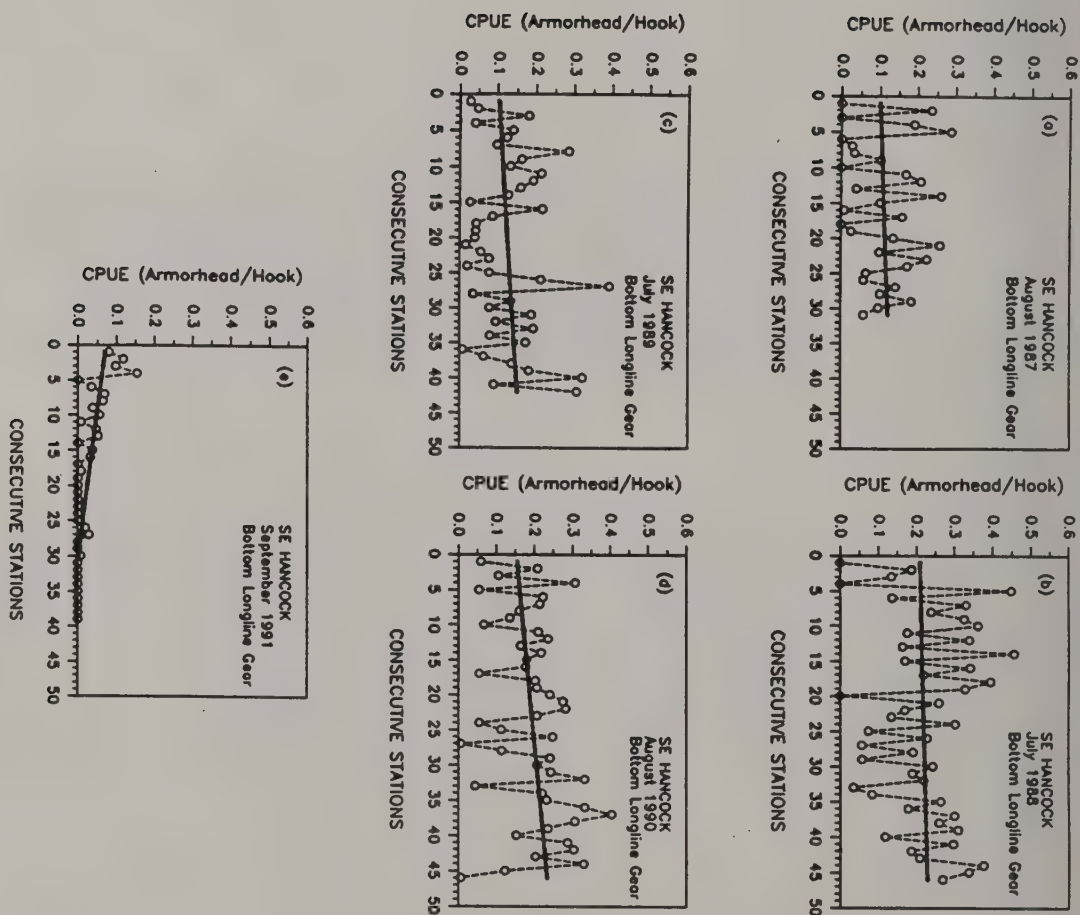


FIGURE 1

INDEX OF SHARK ACTIVITY DURING DIGITAL TIMER LONGLINE SURVEYS

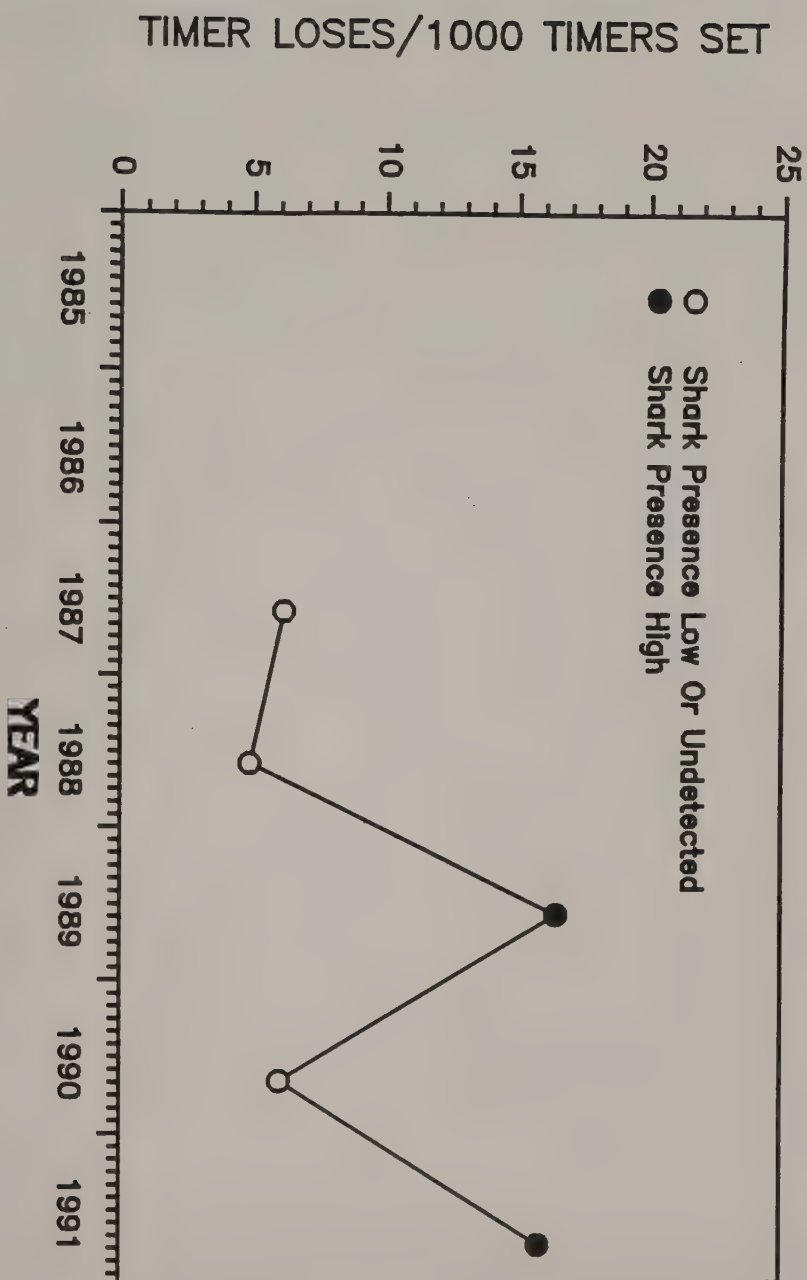


FIGURE 2

Appendix 2. NMFS Administrative Activities

NWHI Limited Entry Program

For the calendar year 1991, a total of 36 vessels were issued permits for the Northwestern Hawaiian Islands (NWHI) bottomfish fishery. This is the highest number of permits issued by the Southwest Region, National Marine Fisheries Service (NMFS) since the NWHI bottomfish limited access program went into effect in 1989. Thirty vessels held Mau (qualifying) Zone permits of which 18 were renewals from the previous year, 10 were first-time permits, and two were for vessels re-entering the fishery after a few years absence. The number of Mau Zone vessels increased 20 percent from 25 in 1990 to 30 in 1991. Six vessels held Ho'omalulu (limited access) Zone permits (4 renewals and 2 new entries) in 1991, an increase of 2 permits over the previous year.

Ho'omalulu Zone Fishing Vessels:

Anna Riley
E.T.
Fortuna
Ipokai
Kaimi Kai (replacement for F/V Kawamee)
Laysan

Mau Zone Fishing Vessels:

Aikane 49	Jenine	Mavis
Blue Sky	Jodan	Nanbellis Jo
Dasher II	Kai Ola	Red October
Goldstar	Kathleen	Sea Eagle
Halfmoon Bay	Kathy B	Seung Ri Yi
Honua-Oe	Kia Hao	Spacer K
Ia Orana	Lei Alana	Spirit
Imua	Liberty	St. Peter
J-Natsuko-O	Lisa I	Three Jacks
Janel-O	Maka Pueo	Windwalker

Protected Species

As of November 27, 1990 all bottomfish vessel operators intending to fish in the NWHI protected species zone were required to notify NMFS prior to departure so that an observer could be placed aboard if directed by the Regional Director, Southwest Region (55 FR 49050, November 26, 1990; 56 FR 5159, February 8, 1991). A final rule implementing this emergency regulation on a permanent basis was published on May 30, 1991 (56 FR 24351). The primary purpose of these regulations is to detect

and record interactions between the fishery and protected species such as Hawaiian monk seals and dolphins.

Observers were placed on three bottomfish trips to the NWHI from January 1991 through December 31, 1991. There were 47 reported trips by permitted bottomfish vessels to the NWHI during this period. In 1991 greater effort was placed in monitoring the pelagic longline fishery around the NWHI which resulted in lower coverage of bottomfishing vessels in the Mau and Ho'omalulu Zones.

Hawaiian monk seals were observed around the gear on some occasions and took a fish off a bottomfish line in two instances but no negative interactions occurred. Sea turtles do not appear to be affected by this fishing method. A technical report summarizing the results of these observer trips is being prepared.

The observer program in Hawaii was initially under the direction of the Honolulu Laboratory of the Southwest Fisheries Science Center. In July 1991 the observer program was transferred to the Protected Species Program of the Pacific Area Office, Southwest Region. As of October 1991 the Program had two observers on staff to monitor the NWHI bottomfish fleet.

There were no protected species seminars conducted for new captains intending to operate in the Ho'omalulu Zone during this reporting period.

Observers are routinely debriefed after each trip by Southwest Enforcement and the Observer Program Manager. Any information relating to potential violations or observed violations by other vessels is provided at that time. The observer trip reports contain confidential fishing information and are not distributed. After the completion of at least 3 trips the reports are pooled for a summary report.

All of the Bottomfish FMP amendments with the potential to affect listed species have undergone Section 7 consultation to ensure that these actions or the fishery do not jeopardize the continued existence of Hawaiian monk seals, humpback whales, and listed sea turtles. Where appropriate, conservation measures and reasonable and prudent alternatives were provided to the Council by the NMFS to promote recovery and conservation of these species and maintain the no jeopardy standard.

Appendix 3. 1991 Enforcement Activities

One complaint has been received alleging that a vessel was fishing in the Northwestern Hawaiian Islands without a valid permit, and is under investigation.

During 1991 NMFS agents accompanied seven USCG C-130 patrols along the Northwestern Hawaiian Islands. No violations were documented during these flights. The USCG also used some of the Kure flights for fishery surveillance.

There were no substantiated reports or detection of illegal gear or fishing methods in the NWHI.

No violations of the reporting requirements have been documented.

The NMFS Law Enforcement Division has received very few complaints, and have not witnessed any violations of the Fishery Management Plan for the Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region.

Appendix 4. Habitat Conditions

Under the Fishery Management Plan (FMP), regulations were implemented to prohibit the use of bottom trawls, bottom-set nets, explosives and poisons for harvesting bottomfish. This has served to greatly reduce the potential for bottomfish habitat degradation. To our knowledge, there have been no violations of these regulations in 1991. The limited entry program further reduces the potential for bottomfish habitat damage.

There are several activities occurring or reportedly occurring in the FCZ which potentially may alter bottomfish habitat. These include:

1. Anchor damage by vessels attempting to maintain position over productive bottomfish habitat.
2. Habitat damage from heavy weights and line entanglements during normal hook-and-line bottomfish operations.
3. Habitat damage by illegal foreign fishing activities for precious coral using coral dredges.

Any potential threat to bottomfish habitat will be reviewed through the Council's Ecosystems and Habitat Committee. The Council has adopted a Habitat policy which will assure that each fishery management plan includes all available information on habitat significant to the species to be managed.

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